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HSL No. 76-09  
September 1976

# Highway Safety Literature

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# STATIC BRAKE INSPECTION INVESTIGATION

## Summary Report

by Avco Systems Division, Wilmington, Massachusetts

### ABSTRACT

This program generated a set of inspection criteria and techniques for the conduct of static (non-performance) brake inspections for passenger vehicles and light trucks without removing wheels. The static brake inspection system was based on a survey of the state-of-the-art of existing systems, criteria and techniques, as well as a thorough literature search. The basic performance objectives of a static brake inspection system were determined based on trade-off studies of inspection items and available inspection methods. The most promising approaches were evaluated and a preliminary system was generated. Because of the need to make use of common vehicle modifications, a dialogue with auto manufacturers was established and the inspection system was carefully re-examined from the point of view of cost, producibility and lead time required for incorporation into production vehicles. Based on this research, a final specification for a static brake inspection system and the procedure for carrying out static inspections in a cost-effective manner were defined. The system was demonstrated with three typical modified vehicles and with demonstration models.

### PREFACE

This summary report of the static brake inspection investigation describes research conducted by Avco Systems Division for the Department of Transportation, National Highway Traffic Safety Administration (NHTSA), Washington, D.C. The work was accomplished under Contract DOT-HS-4-00949 from July 1974 to June 1976. The NHTSA Contract Technical Managers were Mr. W. Lemeshefsky and Mr. J. Goulart.

The program was contracted to Avco Systems Division, Wilmington, Massachusetts. The responsible De-

Mr. A. Glickman, Department Manager. The work was performed under the project management of Mr. Thomas Forman. Other principal investigators were:

D. A. White—Chief Investigator

Mr. R. Cowan—Assistant Investigator

The program was further supported by work subcontracted to Artec, Inc., St. Louis, Missouri, with Mr. Francis Oldham as Chief Investigator. Considerable additional support was given to the program by industry dialogue with significant contributions from the engineering staffs of Bendix Corp., General Motors, Ford Motor Company, and the Kelsey Hayes Corporation.

### 1.0 INTRODUCTION

This document represents Volume I of the final report for the static brake inspection investigation. It provides a summary of the program activities and results. Volume II, Final Technical Report, is sold by the National Technical Information Service, Springfield, Va. 22161, as PB-262 792, and contains a detailed description of the program activities and Volume III, when published, will contain technical appendices for reference purposes.

Previous NHTSA research indicated that efficient brake inspections had a potentially high payoff in the vehicle-in-use program because brake system component failure and degradation contributed a significant percentage of accidents caused by mechanical failures. Starting in 1968, programs devoted to better brake inspections were initiated. These programs resulted in the definition of the specific parameters and subsystems of brake systems that would provide the best payoff in terms of safety inspections. The generation of the brake inspection methodology resulted further in the definition of two important aspects of such inspections: dynamic (performance) and static

these findings, this program was initiated. A way had to be found to perform the static brake inspection *without removing wheels*. As will be shown in this final report, a static brake inspection methodology has been generated that eliminates these shortcomings.

## 2.0 OBJECTIVES

The following basic objectives were addressed by the research:

- A. To conduct a systematic state-of-the-art survey into existing static brake inspection systems, proposed designs, inspected criteria, techniques, and related literature.
- B. To determine basic performance objectives of the static brake inspection system, alternatives, evaluation criteria/weighting requirements, and test methodology for evaluation of alternatives, and preliminary analysis of potential approaches.
- C. To analyze and evaluate the more promising approaches and determine the optimum static brake inspection system.
- D. To construct and evaluate two prototype static brake inspection systems based on selected usable portions of the evaluated equipment and/or new design requirements as needed, and develop the related inspection criteria and techniques.
- E. To demonstrate and verify both the operational capabilities of the equipment and the validity of the inspection criteria and techniques to detect and assess the condition of automotive braking systems in the static state.

As a result of the literature search, analysis experimentation and trade-off studies that were conducted to achieve the first three of these objectives, a change in the objectives for the program was found to be necessary. Based on the conclusions reached in the preliminary specification and discussions that took place

of existing static brake inspection systems, proposed designs, inspection criteria, techniques, and related literature.

- B. To determine basic performance objectives of the static brake inspection system, alternatives, evaluation criteria/weighting requirements, and test methodology for evaluation of alternatives, and preliminary analysis of potential approaches.
- C. To analyze and evaluate the more promising approaches and determine the optimum static brake inspection system.
- D. To establish a dialogue with at least one automotive and two brake system component manufacturers to obtain preliminary price and lead time information and to optimize the system on industry inputs.
- E. To modify at least three vehicles (furnished as Government furnished equipment) with access ports and wear indicators based on this dialogue and to conduct test and time studies of a static brake inspection procedure.
- F. To update the system and procedures based on the achievement of the above objectives and to incorporate them into at least one vehicle for demonstration purposes.
- G. To establish a pedal load application test based on technical data showing the usefulness of such a procedure, the feasibility of using the proof test for the detection of safety critical faults without accelerating component deterioration and to establish a reasonable load and rate of application based on establishing the existence of such loads during high-panic applications.
- H. To conduct a demonstration of the system with hardware, vehicle modifications and test procedures developed during the program.



Section 5.0 describes the resulting specification.

### 3.0 DEVELOPMENT WORK

The development work may be divided into four important phases. The first phase deals with surveying existing literature, studying the brake system and conducting basic experimentation with equipment and component parts. It was a fact finding and orientation phase upon which the more creative research was based.

During this phase the inspection criteria for every part of the brake system were defined, whether it was to be included in the eventual inspection scheme or not. A full review of existing inspection technology also took place. At the conclusion of this phase of the work, items that could be inspected and methods for inspection were traded off and a matrix of items and methods for further investigation was created.

The second phase concentrated on an in-depth technology investigation. The items to be inspected had been identified but not enough was known about the technologies—such as X-ray or ultrasonics—to judge whether a given technology could be applied to inspect a particular item. The end product of the technology investigation was a clear understanding as to the ability of a given technology to be used for static brake inspection purposes. Since access ports, visual indicators, and a proof test appeared the only viable method, some experimentation, vehicle modifications and road tests were conducted during this phase of the work.

The third phase was a summation and decision making effort. The ability of a given method to inspect an item having been established previously, it remained to decide what the preliminary static brake inspection should include. An inspection matrix was prepared for use in the generation of the preliminary specification.

The fourth phase of the development work consisted in generating a preliminary specification and a set of procedures that were to be used with the suggested static brake inspection. The midterm report was prepared and the midterm meeting with NHTSA was conducted.

Each document reviewed for the literature search was synopsisized and categorized under one of four headings:

- A. Test Methods
- B. Test Criteria
- C. Construction and Features of Test Item
- D. Patents

These categories are discussed in the body of the final report and the synopses are contained in the appendix.

A study of items to be inspected was conducted and those items essential for a static brake inspection were culled from a detailed list. The following items were selected:

#### Friction Materials.

- Lining and pad thickness
- Hub seal leakage

#### Wheel Cylinder Condition and Operation

- Drum and disc wheel cylinder leaks

#### Drum/Disc Size and Condition

- Drum internal diameter
- Drum and disc cracks
- Disc thickness

#### Brake System Integrity

- Lining in correct location
- Drum brake adjustment mechanism
- Drum and disc guide, clips, springs, cotter pins, etc.
- Master cylinder fluid level
- Brake line/hose connection leaks, abrasion/corrosion
- Brake fluid moisture contamination
- Brake fluid sludge
- Master cylinder external leak

Having selected the items and arrived at a thorough understanding of available methods for inspection, a trade-off study was conducted to match items to methods from the point of view of cost, safety, capability to perform the inspection and public acceptability. The trade-off study yielded the matrix shown in Table 3-1.

The investigation of technologies included research of methods that were rejected during the trade-off studies described in Section 3.1. The research took place before the trade-off studies. Its results are included in the final report because they may be useful material for future reference. For summary purposes, only the description of the method and the conclusions are presented.

This technique uses X-rays to pass through the object to be examined and to examine the resulting image by using fluorescent screens or photo sensitive material. The image shows the items within the object based on their density variation. It was concluded that this method could not be used for disc brakes, and was of questionable feasibility for drum brakes. It requires expensive equipment and presents a substantial safety hazard.

**TABLE 3-I**  
**Inspection Methods Selected for Further Investigation**

Final Selection Inspection Items	Inspection Methods						
	Gas Chroma- tography	Fiberoptics	Dielectric Strength	Visual Inspection With Proof Test	Mechanical Measure- ments	On-Board Sensors (All Types)	Visual Indicators
Thickness of:							
Disc Pad		X				X	X
Lining		X					
Leakage:							
Wheel Cylinder	X	X					X
Hub Seal	X	X					
Disc:							
Thickness		X			X		
Cracks		X					
Drum:							
I.D.							X
Cracks		X					
Drum System							
Adjustment Mechanism		X					
Correct Part & Location:							
Guides, Clips		X					
Drum Shoes		X					
Master Cylinder:							
External Leak	X			X			
Fluid Level				X			
Line/Connection:							
Leak	X			X			
Abrasion Corrosion				X			
Fluid Contamination:							
Moisture			X				
Sludge				X			

- **Ultrasonics**

Ultrasonics involves the use of vibration waves that are generally above the audible range and greater than 20,000 Hz. Flaws and interfaces between material types may be readily detected using this equipment since the length of the propagated wave is on the same order of size as the defects being sought. Most metallic materials, because they demonstrate excellent elastic properties, readily transmit ultrasonic energy. Discontinuities, which have lower transmissibility, cause measurable scattering or reflection of the ultrasonic energy and thus become immediately apparent.

It was concluded that because of the sonic velocity variations inherent in brake materials, ultrasonics is not a feasible method of measuring thickness of pads, linings, discs or drums for PMVI. Secondly, the existing practical coupling techniques will not allow measurement of the pads or linings due to the air interface. Lastly, echos from the discontinuities of vented discs and ribbed drums will complicate their detection to a degree forcing an unacceptably high operator skill level. Ultrasonics is not a feasible technique for inspecting brakes.

- **Fiberoptics**

Fiberoptics refers to specially made glass or plastic fibers that have the ability to conduct light. Coating or cladding of each fiber with a transparent glass of lower refractive index prevents loss of light through the side of each fiber. Flexible fiberoptic bundles are made up of a quantity of individual coated fibers twisted together for flexibility, inserted into a flexible metallic sheath for protection, and fused together in metal ferrules at each end. If the bundle is to be used to transmit light only, fiber orientation is not controlled. If the bundle is to be used to transmit an image, each fiber in the bundle must be precisely oriented in relation to every other fiber at both ends. Fixed or variable optics and articulation control can be added to the bundle to suit the applications. The wide medical and industrial use of this technique encouraged Avco initially. Considerable experimentation and research effort was concentrated on this method. The results were dis-

appointing. It was not possible to identify the object under examination in an objective and timely manner.

- **Gas Chromatography**

Gas chromatography is a technique for separating substances based on differential absorption times. The unknown gas or liquid is introduced into a column of absorbing material for sufficient time to fully absorb the sample. A solvent is then moved slowly through the column causing the various substances in the column to desorb. Since the desorption of each substance occurs at different time intervals, they become separated and move out of the column in stratified layers. A detector at the column exit is used to identify each substance as it flows out. For example, a Katharometer detector identifies gases by monitoring their thermal conductivity.

Based on analysis and experimentation, it was concluded that gas chromatography is a technically feasible method for inspecting wheel cylinder leaks but that an extensive development program would be required. It is a complex and costly approach with a high risk of failure at some point in development or application.

- **Spectrographic Analysis**

Since each chemical element produces known spectrum lines, and since burning in an arc or spark will dissociate almost any sample of material into its constituent elements, these stand revealed when the spectrum of the light from the sample is studied. This technique is used by some automobile manufacturers as a quality control technique on brake fluids which they purchase. It is also used for analysis of engine oil from aircraft, marine, and locomotive engines to identify abnormal concentrations of wear metals, as a means of obtaining early warning of impending engine failure.

It was concluded that this technique is not at this time far enough developed to be practical for use in PMVI brake inspection because of high equipment cost and high operator skill requirements. The technique has excellent potential for measuring brake fluid contaminants, as part of PMVI, if and when low cost easily operated equipment becomes available.

- Techniques for Measuring Moisture in Brake Fluids

Equilibrium Reflex Boiling Point (ERBP), dielectric strength, electrical resistance, capillary action, chemical moisture detection, titration and gas chromatography were considered as methods for detecting moisture in brake fluids. These investigations resulted in the conclusion that although some of the above methods may be used for some one fluid, no useful technique for PMVI use of all vehicles exists. Additionally, it appeared unnecessary to conduct such inspections as part of the static brake inspection system. The chemical moisture detection technique has the greatest potential for the future. Table 3-II summarizes the results of these investigations.

- Proof Test

The proof test consists in applying a load to the brake pedal in order to observe whether this load causes leaks of the hydraulic system or mechanical failures. Because it is a potentially destructive test, it is a somewhat controversial method. Considerable research was done in this area both before and after the midterm meeting.

The conclusion of the proof test investigation was that a 200-pound proof test should be used for

static inspections. This figure is used in the preliminary specification. The preliminary specification used a figure of 400 pounds.

- Mechanical Measurements

This technique consists in the use of conventional measuring devices such as vernier calipers, micrometers, etc. to determine the thickness of brake linings, rotors, or such items as the internal diameter of brake drums. Our investigation was limited to disc thickness only.

Since visual wear indicators and access ports were already selected for several inspection areas, we decided to include disc thickness among those items to be checked with visual indicators. This would eliminate the need for a data bank and more time consuming inspection method.

- On-Board Sensors

On-board sensors are devices built in the vehicle to warn the driver of the wear status of his brake linings or other safety critical items. They are being used in the form of audible signals, generated by metallic reeds that impinge on the rotor surface when a certain degree of wear of the lining material has occurred. Foreign manufacturers use electrical sensors that display warning lights on the dashboard of the car.

**TABLE 3-II**  
**Summary of Brake Fluid Moisture Detection Techniques**

Technique	Parameter Measured	Sample Required	Measurement Time Estimate	Operator Skill Level	Equipment Cost Estimate	Comment
Reference Technique ERBP	Fluid boiling temperature	Yes 60 ml.	17 min.	High	\$200	Suitable for laboratory only.
Dielectric Strength	-----	-----	-----	-----	-----	Does not work.
Electrical Resistance	% moisture content	No	2 min.	Low	\$100	Cannot be standardized for all brake fluids.
Capillary Action	% moisture content	-----	-----	-----	-----	Does not work.
Chemical Moisture Detector	% moisture content	Yes	2 min.	Low	Negligible	Conceptual only, needs development. Best potential technique.
Titration	% moisture content	Yes 1 ml.	5 min.	Low	\$2,500	Good existing technique. Can be automated.
Gas Chromatography	% moisture content	Yes	5 min.	High	\$16,000	Too costly.
Markey Vapor Lock Indicator	Vapor lock temperature	Yes 6.5 ml.	5 min.	Low	\$475	Best existing technique.

An in-depth investigation of on-board sensors was conducted. A paper on this subject was presented to the SAE, authored jointly by Mr. T. Forman of Avco and Mr. W. Lemeschewsky of NHTSA. It was concluded that this method is well suited to warn a driver of impending maintenance or safety problems, but poorly suited to aid an inspector during routine PMVI.

#### • Visual Wear Indicators

Visual wear indicators consist in special configurations of wear items such as brake linings and their mating surfaces. The presence or absence of the configuration or, in some cases, the ability to observe or feel a step in the material, tells the inspector that the item is either serviceable (accept) or worn out (reject). This approach is used in conjunction with suitable access ports and

simple inspection tools (light and small mirror) to provide a simple and fast inspection without wheel removal.

The major drawback of this method is the fact that vehicle modifications are required and that these modifications have to conform to predetermined specifications. It has the potential to make fast, objective inspection to the brake system without wheel removal a reality. Considerable effort was spent during the development phase to assure that wear indicators can really do the job. Three vehicles were modified and one was driven over 2,000 miles under adverse conditions in order to establish the basic feasibility of this approach.

This feasibility was established and the wear indicator method thus became the key to the solution of the problems posed by the static brake inspection investigation.

**TABLE 3-III**  
**Summary of Technology Investigation**

ra.	Technology/Inspection Method	Comments
.1	Radiography	<sup>1</sup> Eliminated—Technically not feasible.
.2	Ultrasonics	<sup>1</sup> Eliminated—Technically not feasible.
2.3.1	Acoustic Emissions	<sup>1</sup> Eliminated—Expensive and impractical.
2.3.2	Acoustic Signatures	<sup>1</sup> Eliminated—Vehicles are too variable.
.2.4	Fiberoptics	<sup>1</sup> Eliminated—Orientation and identification problem.
2.5	Gas Chromatography	<sup>2</sup> Eliminated—Technically feasible but expensive and high risk development needed.
2.6	Spectrographic Analysis	<sup>1</sup> Eliminated—Technically feasible but expensive equipment and high skill required.
.7	Moisture Detection in Brake Fluids	Deleted as an inspection item—Of doubtful value to PMVI.
	1. Dielectric Strength	<sup>3</sup> Eliminated—Does not work, brake fluid is conductive.
	2. Electrical Resistance	<sup>3</sup> Eliminated—Cannot be standardized for all brake fluids.
	3. Capillary Action	<sup>3</sup> Eliminated—Does not work, poor correlation.
	4. Chemical Moisture Detector	<sup>3</sup> Potential—Conceptual only, needs development; best potential technique.
	5. Titration	<sup>3</sup> Potential—Good existing technique, can be automated.
	6. Gas Chromatography	<sup>3</sup> Potential—Good but too expensive.
	7. Markey Vapor Lock Tester	<sup>3</sup> Potential—Best existing technique.
2.8	Proof Test	<sup>2, 4</sup> Selected—Fast, practical conditioning technique for leaks.
.2.9	Mechanical Measurements	<sup>2</sup> Eliminated—Requires vehicle modification with small payoff.
.2.10	On-Board Sensors	<sup>2</sup> Eliminated—Suitable for driver but not inspector.
2.11 & 12	Visual Indicators	<sup>2, 4</sup> Selected—Access ports and visual indicators are highly feasible.
3.2.13	Fifty-Four Vehicle Test	Rated certain inspection items: Retained master cylinder external leak, low priority on brake fluid sludge, retained disc brake guides and clips, low priority on drum brake clips and springs.

<sup>1</sup> Eliminated during initial trade-off.

<sup>2</sup> Further investigated.

<sup>3</sup> Inspection methods are rated even though inspection item was deleted.

<sup>4</sup> Selected approach for preliminary specification.

TABLE 3-IV

STATIC BRAKE INSPECTION METHODS AND PASS/FAIL CRITERIA

Inspection Function	Inspection Goals (From Initial Report)			Inspection Adjudicator (From Tank & Evaluation)										Measurement	
	Adverse Criteria	Failure Criteria	Measurement	Value Indicator	Selected Inspection Methods					Adverse Criteria	Failure Criteria	Range	Accuracy	Range	Accuracy
					Visual	Accord	Porta	RB	Visual	Visual	Visual	Visual	Visual		
FRICTION MATERIALS	Lining Thickness	Less than 1/8"	Greater than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	N/A	Go/No-Go
	Pad Thickness	Less than 1/8"	Greater than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	Less than 3/8"	N/A	Go/No-Go
	Pad Taper	None	None	None	None	None	None	None	None	None	None	None	None	Qualitative	Qualitative
Hub Seal Leakage	0.010 inch/inch of pad length	Slight leakage	Qualitative	Qualitative	X	X	X	X	X	X	X	X	X	Qualitative	Qualitative
WHEEL CYLINDER CONDITION	Drum wheel Cylinder Leaks	Any evidence of weeping	Qualitative	Qualitative	X	X	X	X	X	X	X	X	X	N/A	Go/No-Go
Drum wheel Cylinder Leaks	Any evidence of weeping	Qualitative	Qualitative	Qualitative	X	X	X	X	X	X	X	X	X	Qualitative	Qualitative
DRUM & SHAFT SIZE AND CONDITION	Drum Inside Diameter	Exceeds discard limit marked on drum	9 to 13"	±0.001	X	X	X	X	X	X	X	X	X	N/A	Go/No-Go
Drum Cracks	Any flex crack that does not reach an edge	Qualitative	Qualitative	Qualitative	X	X	X	X	X	X	X	X	X	N/A	Go/No-Go
Disc Thickness	Exceeds discard limit plus 50% of allowable allowance	Qualitative	Qualitative	Qualitative	X	X	X	X	X	X	X	X	X	N/A	Go/No-Go
Disc Cracks	Any flex crack that does not reach an edge	Qualitative	Qualitative	Qualitative	X	X	X	X	X	X	X	X	X	Qualitative	Qualitative
SHAKE SYSTEM INTEGRITY	Linkage in Correct Location	None	Qualitative	Qualitative	X	X	X	X	X	X	X	X	X	Qualitative	Qualitative
Drum Brake Adjusters	Drum Brake Adjusters	(1) Adjuster Inoperative. (2) Drum to lining clearance less than 1/16" at wheel cylinder end.	(1) Qualitative (2) 0.028 Go/No-Go	Qualitative	X	X	X	X	X	X	X	X	X	(1) Qualitative (2) N/A	Go/No-Go
Drum Brake Springs, Clips, etc.	Presence of any loose spring or clip within the brake assembly	None	Qualitative	Qualitative	X	X	X	X	X	X	X	X	X	Qualitative	Qualitative
Disc Brake Guide, Clips.	None	None	Qualitative	Qualitative	X	X	X	X	X	X	X	X	X	Qualitative	Qualitative
Nearer Cylinder Level	Less than 3/4 full	Less than 1/2 full or less than 1 inch from the bottom	0 to 3"	± 1/16"	X	X	X	X	X	X	X	X	X	N/A	Go/No-Go
Brake Line/Connection, Leaks, Friction, Corrosion	None	Any evidence of fluid weeping leaking at or after a joint test	Qualitative	Qualitative	X	X	X	X	X	X	X	X	X	N/A	Go/No-Go
Brake Fluid Sledge Contamination	Any evidence of sludge in master cylinder	None	Qualitative	Qualitative	X	X	X	X	X	X	X	X	X	Qualitative	Qualitative
Master Cylinder External Leak	None	(1) Unsanitary brake. Any evidence of leaks around push rod. (2) Antistored brake. Any evidence of leaks in vacuum chamber.	Qualitative	Qualitative	X	X	X	X	X	X	X	X	X	Qualitative	Qualitative
Gross Master Cylinder Internal Leak and/or Gross Air Contamination	Inspect as Per of Dynamic Test	None	Qualitative	Qualitative	X	X	X	X	X	X	X	X	X	N/A	Go/No-Go

Note: Cannot distinguish between static and dynamic test. Use function energy with dynamic test.

### 3.3 SUMMARY AND CONCLUSIONS FROM TECHNOLOGY INVESTIGATION

The technology investigation is summarized in Table 3-III. Several exotic technologies such as radiography and ultrasonics were eliminated during the initial trade-offs and the more promising ones further investigated. Based on this investigation, we concluded that access ports, visual indicators and a proof test provided the best approach to static brake inspection without removing wheels. The preliminary specification was prepared based on this conclusion.

### 3.4 PRELIMINARY SPECIFICATION

The preliminary specification generated as a result of the development work defines the modifications required to perform a static brake inspection on any vehicle that is suitably modified. It specifies lining, pad, drum and disc wear indicators and access ports through the outside of the wheels. It also calls for a proof test and the use of simple mirrors and small inspection lights to see the indicators.

The need for a very general specification, that leaves the manufacturer free to provide the most cost-effective wear indicators for his particular design, was not clearly recognized at that time. Thus the preliminary specification attempts to be far more specific than the final recommended specification of Section 5.0. Table 3-IV shows the static brake inspection method and pass/fail criteria that apply to this preliminary specification.

### 4.0 SYSTEM FINALIZATION

The preliminary specification was incorporated into the midterm report and used as the basis for the midterm meeting. As a result of NHTSA's acceptance of the basic concept (use of vehicle modifications), the scope and objectives of the remainder of the program were changed. It was felt important to establish a dialogue with industry for two reasons:

1. To determine whether brake manufacturers and auto makers would fight the approach.
2. To learn about the manufacturing methods used in fabricating brake systems.

Having obtained sufficient insight into these two important points, the static brake inspection system could then be updated to make it acceptable or, if possible, even welcome.

The three government furnished vehicles were then modified according to the best interpretation of the dialogue with the manufacturers. Tests and time studies were conducted in order to complete the baseline of information needed for generating the final specification.

The next step in finalizing the system was to rethink all the basic considerations and reap the maximum benefit from the experience gained throughout the program. Based on this reevaluation the final specification which includes the requirements for vehicle modifications, the criteria for inspection, the procedure to be used, and the tools that are required, was generated.

Section 4.1 describes the industry dialogue.

Section 4.2 describes the modification and test program carried out on the three vehicles and section 4.3 contains the analysis and testing underlying the generation of the final specification.

#### 4.1 INDUSTRY DIALOGUE

A dialogue with industry was conducted through presentations to the Society of Automotive Engineers, the Bendix Corporation, General Motors Corporation, and the Kelsey-Hayes Company. The essential content of this dialogue is presented in the main body (Vol. II) of this report. It spans a seven month period from July 1975 to January 1976.

The results of these meetings with industry were gratifying. There were no basic objections to the visual wear indicator concept. However, our suggested methods were at first found to be unacceptable from a manufacturing point of view. The industry teams with whom we dealt were extremely helpful in suggesting ways of modifying our approach in such a way as to minimize manufacturing cost and in many cases to improve the effectiveness of the static inspections.

A review of our program was conducted at each meeting. The results of industry reaction may be summarized as follows:

- An inboard approach to access ports in backing plates and splash shields is more practical than access ports in wheels and drums. It avoids highly stressed parts, wheel-to-drum alignment problems and reduces inspection time. The inboard approach was incorporated in the recommended specification.

- The feasibility of the basic approach was confirmed by our dialogue with industry.
- The dialogue with industry strongly confirmed that a variety of design solutions to the configuration of access ports and visual indicators is needed. Provision for a variety of design solutions should be incorporated in the recommended specification.
- For both discs and drums, it is desirable from the industry's point of view that wear indicators be characterized as a continuous circular surface concentric with the ID of the drum and hub of the rotor. This type of wear indicator is easier to manufacture than a spot cut or discontinuous surface.

The objectives of the dialogue were accomplished and exceeded. It became apparent that the basic idea was gaining ground and that industry welcomed our attempts to seek their inputs prior to making any suggestions that could conceivably result in legislation.

## 2.2 MODIFICATION OF TEST VEHICLES

As a result of the redirection that the program received at the midterm meeting, three vehicles were modified in conformance with the understanding gained by the dialogue with industry. The vehicles were 1973 production cars with disc and drum brakes: a Ford Pinto two-door station wagon, a Dodge Challenger two-door sedan and a Buick Riviera. The basic approach was to inspect the brakes from under the vehicle working from the inside out. The access ports for the drum brakes were placed in the backing plate. A small ( $\frac{1}{4}$ " diameter) light source and a front surface mirror on a handle were the only inspection tools required to view the wear indicators. A very simple gauge was used to measure the distance between the inside surface of the drums and the lining. This method had been evolved after discussion with industry. It is used to determine whether the automatic adjusters for the drum brakes are working. A pedal load indicator was placed between the operator's foot and the brake pedal for the proof test. The right sides of the vehicles were prepared to simulate the extreme (reject) condition of wear for pads, linings, discs and drums. The left sides were put into "as new" condition.

Experimentation to find the best mirrors, light source and procedure for conducting every element of the inspection was then carried out. When the inspection was reduced to a method satisfactory to Avco and the CTM, time studies were conducted to arrive at an initial value for inspection time. The following breakdown was arrived at:

Location	Time (Minutes)
Driver's Seat	1
Underhood	2
Left Front Wheel (Disc)	1½
Right Front Wheel (Disc)	1½
Brakelines to Rear	½
Left Rear Wheel (Drum)	1
Right Rear Wheel (Drum)	1
	8½

A review of the resulting inspection took place and a decision was reached to update the modifications in several areas:

- The wear indicators for the pads were moved from the wear surface to the brake shoe (the metal backing holding the lining material).
- The drum wear indicator was changed to a continuous groove with a corresponding clearance slot in the lining.
- The backing plate access ports were enlarged to provide better visibility for the drum wear indicators.
- Access ports were provided with covers to exclude contamination. It is unclear whether this is necessary and should be left to the manufacturer's engineering judgment; however, gaining experience in this area was felt to be useful.

As a result of the review, a simple three-cycle test was conducted to simulate wear and contamination conditions. These tests showed no significant effect and allowed the conclusion that the modifications are feasible for production vehicles. However, testing and design refinements will have to take place on the part of manufacturers, should the static brake inspection system be adopted or legislated.

Time studies were undertaken with the updated design. Table 4-I provides a summary of the results



of these time studies. The following table shows how this time may be reduced by introducing certain improvements and simplifications to the procedure:

	Total Inspection Time in Man- Minutes
Typical Full Up Inspection Time (Ref. 4.2.2-1)	10¼
Delete lift and use pit instead (-1 min.)	8¾
Delete wheel rotation (-1 min.)	7¾
Delete sludge examination (-¾ min.)	7
Delete rear brake inspection (-3½ min.)	3½

It can be seen that the time to perform a static brake inspection is very significantly reduced compared to today's practice of "wheel pulling." Various time studies of this procedure and observations during Avco's engineering support program to the Title III demonstration project showed that a wheel pull may take anywhere from 8 minutes to 15 minutes per wheel. This makes a 10 minute inspection of all four wheels attractive from a PMVI point of view, even without considering the greater objectivity that will be achieved with the new system.

## 4.3 RETHINKING THE INSPECTION SYSTEM

This effort was directed at fully utilizing the knowledge, experience and methodology that had been developed throughout the program in order to produce an optimized final specification. The general philosophy was first addressed, and, based on this, past methods, criteria and procedures were reviewed and updated.

The important considerations in this rethinking process were:

- Elimination of "Advise Criteria"

It is very doubtful whether for PMVI purposes advise criteria can ever be effective. Additionally, the introduction of an advise category complicates the inspection and imposes the need for two readings for each wear indicator. Advise criteria were dropped from the system.

- Ability of the System to Accommodate Changes

Changes in brake design that are pending in the near and distant future were considered and the system was examined to assure it will be able to handle changes. As for example: four wheel disc brakes on more vehicles, hydrau-

**TABLE 4-I**  
**Summary of Inspection Time Study Results**

Inspection Location	Inspection Steps (Ref. Data Sheet)	Average Inspection Time in Minutes		Rounded Off Typical Time Estimate (Minutes)
		Initial	After Conditioning	
Driver's Seat	1→3	.95	.84	1
Under Hood	5→11	1.85	1.72	1¾
Lift Vehicle	12	.68	.68	½
Left Front Wheel	13→18	.96	1.16	1¼
Right Front Wheel	19→25	.95	1.24	1¼
Brake Lines to Rear	26	.46	.47	½
Left Rear Wheel	27→34	1.62	1.20	1½
Right Rear Wheel	35→43	2.08	1.31	1½
Lower Vehicle	44	1.10	.81	1
Total Time		10.65	9.43	10¼

drums, new brake fluids, etc. It was found that the system will be able to accommodate such changes without any problems.

#### • Consider Constant Elements of Brake Design

It is important that the static brake inspection system has the ability to inspect today's vehicles with certain well established elements and design practices such as the use of front disc brakes of the floating caliper design, rear drum brakes with automatic adjusters, proportioning and metering valves. The approach used by the static brake inspection system is based on a thorough knowledge of these constant elements; however, a careful review of inspection technology is important before final definition of the specification.

The review of inspection items, criteria and methods resulted in clear definitions for use in the final specification. The philosophy of using only "accept" or "reject" as the inspection verdict for each item had a strong bearing on the inspection criteria and made it possible to simplify the wear indicators.

Part of the rethinking process was to prioritize the inspections so as to make it possible to reduce inspection time and cost in a non-arbitrary manner. The following priority ranking with the most safety critical item as number 1 was arrived at:

1. Master cylinder external leak (disc reservoir)
2. Brake line/hose/connection leak (disc)
3. Disc capliper cylinder leak (gross leak)
4. Disc brake pad & caliper retention parts
5. Disc caliper cylinder leak (slight leak)
6. Hub lubricant leak (disc)
7. Pad thickness
8. Rotor thickness and symmetry
9. Drum wheel cylinder leak (gross leak)
10. Master cylinder external leak (drum reservoir)
11. Brake line/hose/connection leak (drum)
12. Drum wheel cylinder leak (slight leak)
13. Hub lubricant leak (drum)
14. Drum self-adjuster mechanism
15. Drum brake springs & clips
16. Lining thickness
17. Drum internal diameter
18. Brake failure indicator light
19. Master cylinder reservoir fluid level

finned and standardized. The vehicle modifications may then be specified as enabling the "Referee Tools" (mirror and light source) to be used for the specific inspections.

It was also found important to recommend that an SAE specification be generated for a standard remaining lining thickness that will permit the last 3,000 miles of driving. This will make it possible to specify miles left on the linings rather than a particular thickness that may change with different lining materials.

The highlights of the system then are:

- No wheel pull.
- No expensive technology.
- Inspect from under car from the inside out.
- Use "Referee Tool" concept.
- Recommend 3,000 miles lining standard.

The adoption of these main considerations in the final specification will assure that it takes full advantage of the industry dialogue and be as acceptable as possible to all manufacturers because it does not dictate design.

## 5.0 FINAL SPECIFICATION

The program resulted in a recommended final specification. This specifies the vehicle modifications, inspection tools, reject criteria and procedure.

### 5.1 VEHICLE INSPECTION REQUIREMENTS (MODIFICATIONS)

#### A. Pad Wear Indicator

The disc brake pad wear indicator shall consist of one or more reference surfaces located at the minimum allowable pad thickness above the backing plate for bonded pads, or above the rivet head for riveted pads. Both inner and outer pads shall have a wear indicator.

#### B. Rotor Wear Indicator

The disc brake rotor wear indicator shall consist of a reference surface on each side of the rotor separated by a distance equal to the minimum allowable rotor thickness, commonly known as the discard limit. If the wear indicator is totally consumed by wear at the discard limit, or if it is located at discrete points on the rotor, then a permanent mark shall be placed on the rotor to aid inspection by signifying the existence of and location of the wear indicator.

#### C. Wheel Cylinder Leak Indicator/Diverter (Drum Only)

Each drum brake wheel cylinder piston shall be equipped with a device that captures any fluid leakage past the piston and diverts it to a leak indicator. The leak indicator shall provide a preferred leakage path, such that any fluid leakage falls outside of the brake assembly where it cannot contaminate the linings and, further, such that any leakage is readily visible to an inspector. The exposed ends of the leak indicator shall be protected to prevent the entry of foreign materials but easily opened for leak inspection.

#### D. Lining Wear Indicator

The drum brake lining wear indicator shall consist of one or more reference surfaces located at the minimum allowable lining thickness above the backing plate for bonded linings, or above the rivet head for riveted linings. The reference surface shall be located either on the horizontal centerline of the axle or close to the point of maximum wear. Both primary and secondary linings (duo-servo brakes) or forward and reverse linings (non-servo brakes) shall have a wear indicator.

#### E. Drum Wear Indicator

The drum wear indicator shall consist of a reference surface located at the discard limit diameter. The reference surface may be continuous or located at two or more discrete points on the diameter. If the wear indicator is totally consumed by wear at the discard limit, then a permanent mark shall be placed on the drum to aid inspection by signifying the existence and location of the wear indicator.

#### F. Hub Seal Leak Diverter/Indicator

Each drum and disc brake, that has the potential for being contaminated by gear oil when seals fail, shall be equipped with a device that captures any lubricant that leaks past the seals and diverts it to a leak indicator. The leak indicator shall provide a preferred leakage path, such that any lubricant leakage falls outside of the brake assembly where it cannot contaminate the linings and, further, such that any leakage is readily visible to an inspector. The exposed ends of the leak indicator shall be accessible for probing to remove any material that has temporarily plugged the leak indicator.

#### G. Master Cylinder Fluid Level Indicator

The master cylinder reservoir shall be so designed that the level of brake fluid inside the reservoir can be seen without removing the cap. In addition, easily

visible markings shall be provided to indicate the maximum and minimum fluid levels recommended by the manufacturer.

#### H. Master Cylinder External Leak Diverter/Indicator

Each master cylinder (power assisted and manual) shall be equipped with a device that captures any fluid leakage past the piston and diverts it to a leak indicator. The leak indicator shall provide a preferred leakage path that makes any leakage readily visible to an inspector. The exposed ends of the leak indicator shall be suitably closed or protected to prevent the entry of foreign materials but easily opened for leak inspection.

#### I. Access Ports

Access ports shall be provided as required to enable visual inspection. Access ports shall be sized to permit visual inspection using only the reference light source and mirror.

#### J. Proof Test

Passenger cars and light trucks under 10,000 pounds gross vehicle weight shall be capable of withstanding a proof test load of 200 pounds applied to the brake pedal for 10 seconds and reacted through the driver's seat. The proof test load is intended to condition a vehicle's brake system for subsequent PMVI static and dynamic brake inspection. This inspectability requirement is applicable to vehicles-in-use only and is not a minimum standard for new vehicles.

## 5.2 INSPECTION TOOLS

Four simple tools are required:

1. A light source
2. A mirror
3. A 1/16" round gauging rod
4. A pedal load indicator

These tools are defined in Volume II of this report.

## 5.3 REJECT CRITERIA

- Lining Thickness—Reject when friction material provides less than 3,000 miles additional wear as shown by the wear indicators.
- Pad Thickness—Reject when friction material provides less than 3,000 miles of additional wear as shown by the wear indicators.
- Wheel Cylinder Leak—Reject when brake fluid drips out of the leak indicator.

- Caliper Cylinder Leak—Reject when the outside lower edge of the dust boot is visibly damp from brake fluid.
- Drum Internal Diameter—Reject when the internal diameter exceeds the manufacturer's recommended discard limit as shown by the visual wear indicator.
- Rotor Thickness and Symmetry—Reject when either side is worn beyond the manufacturer's recommended discard limit as shown by the wear indicator.
- Drum Brake Self-Adjuster Mechanism—Reject when clearance between lining and drum exceeds 1/16 inch radially and 1/8 inch diametrically as indicated by simple gauges.
- Drum Brake Spring and Clips—Reject when there are any loose parts within the lower quadrant of the brake assembly as observed through the access port.
- Disc Brake Pad and Caliper Retention Parts—Reject if unlocked, missing or broken parts can be observed.
- Hub Lubricant Leakage—Reject if gross leakage past bearing seal is visible (see Volume II for further definition).
- Master Cylinder Reservoir Level—Reject when level is less than minimum recommended by the manufacturer as shown by the level indicator.
- Master Cylinder External Leak—Reject when fluid drips out of the dust boot, or leak indicator, or if a slow leak has wetted more than a 4-inch square (approximately).
- Brakeline/Hose/Connection—Reject if there is any evidence of brake fluid leakage on lines, hoses, and connections (dampness, wetting, dripping).
- Brake Failure Indicator Light—Reject if the brake failure indicator lamp is not operable.

## 5.4 PROCEDURE

The following simplified procedure will apply. This procedure is described in greater detail in the body of the final report.

With vehicle on lift or over pit:

1. Driver's Seat—Low and high level proof test, warning light, and leak check.
2. Under Hood—Master cylinder reservoir, line and connection leak check.
3. Under Vehicle—All four wheel brake check plus hoses, lines, and connections.

## 6.0 DEMONSTRATION

The final procedure was demonstrated to NHTSA by using both the Buick Riviera and two special demonstration models of representative drum and disc brakes.

## 7.0 CONCLUSIONS

Avco's investigations have shown that the use of a proof test, visual wear indicators, access ports and simple inspection tools can result in a fast and objective static brake inspection without removing wheels. Legislation is required to introduce this system for PMVI use. The research and specifications contained in this final report can be used to initiate such legislation.

We further conclude, based on our dialogue with industry, that such legislation will be acceptable to manufacturers, provided it is formulated in the performance terms suggested in this report and sufficient time is allowed to finalize their designs.

Based on Avco's experience with vehicle inspection problems, it is our strong feeling that the static brake inspection system, as recommended in this report, provides the basis for a significant advance in the state-of-the-art of motor vehicle brake inspections.

## **ABSTRACT CITATIONS**



HS-018 641

## **AN ENGINEER'S GUIDE TO AUTO AND TRUCK TIRE VALVES**

A basic design guide to valves, indicating the different characteristics of passenger car and truck types, and minimum guidelines for proper valve selection are provided. Illustrations of the following are included: the components of an early tire valve; basic tire valve and components; the internal core chamber and valve core components; different types of side and bottom hole valves; and a super large bore valve with and without inflation adapter.

Publ: Automotive Engineering v84 n4 p40-4 (Apr 1976) 1976

Based on SAE-760 "The Tire Valve: An Important Component of Wheel Systems," by Frank S. Irlinger, presented at the SAE Annual Meeting, Detroit, 23-29 Feb.  
Availability: See publication

HS-018 642

## **HOW PLASTICS ARE USED IN EUROPEAN AUTOS**

The use of plastics and elastomers in European vehicles for weight reduction and lower fuel consumption is discussed. Some of the cost advantages of plastics have been lost because of rising raw materials costs, but the use of plastics of high quality have become more prominent because the prices rose at a comparatively slower pace, and because their strength permits their use for thin-walled parts. Some component usages for plastics are illustrated: front end of automobile; trim; bumpers; and bodies. Thermoplastics can be used in: heater/ventilation units; instrument panel covers; door and luggage area trims; fuel tanks; front grilles; and badges and headlight bezels. Foam plastics can be used in: heat and noise damping; seats; steering wheel rims; and bumpers. Elastomers can be used for flexible front and rear body sections. Also thermosetting plastics are being used for roof panels and bumper reinforcing material.

Publ: Automotive Engineering v84 n4 p47-51 (Apr 1976) 1976

Based on SAE-760173 "Plastics in the Automobile Industry" by Herman Habitzel, presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976.

Availability: See publication

HS-018 643

## **AUTOMOTIVE BATTERIES**

The development of the automotive storage battery and the improvement in its electrical output per pound over the years are discussed. Components and materials, electrolyte function, maintenance-free batteries, and battery manufacture are considered. Photographs of an early (1916-1918) battery and from the modern battery manufacturing process are included.

by Larry Givens

Publ: Automotive Engineering v84 n4 p33-9 (Apr 1976) 1976

Prepared in cooperation with ESB Inc. and Delco-Remy Div., General Motors Corp.  
Availability: See publication

HS-018 644

## **AN OPTIMIZATION MODEL FOR FREEWAY STATIONARY EMERGENCY SERVICE SYSTEMS**

An optimization model for freeway stationary emergency service systems has been developed and applied to the Los Angeles (California) Freeway Surveillance and Control Project. The two major problems which may arise when an accident or other incident occurs on a freeway are: an interruption of traffic flow through reduced capacity, which may cause traffic congestion and delays to the passing motorists; and the waiting time for the necessary service which may be vital to stranded motorists. These two problems may involve high social costs, ranging from delays and property damage to disability or death. Secondary accidents may result in further losses. A good emergency service system should greatly reduce these costs. The stationary service system is interpreted as a queuing system for the purposes of this optimization model. Dynamic programming models were developed to search the optimal structure of the entire system for the purposes of: decreasing total cost; decreasing total delay; decreasing response time; and increasing the service level, in terms of the probability that at least one service vehicle is available when the incident occurs. The dynamic programming is used in conjunction with queueing theory to determine the best locations for service facilities, the optimal number of service vehicles at each service location, and the service area to be covered by an individual service location.

by We-Min Chow

Publ: Transportation Science v10 n1 p20-34 (Feb 1976) 1976 ; 11refs

Research partially sponsored by the National Science Foundation and the Dept. of Transportation.  
Availability: See publication

HS-018 645

## **HOT SPARKS TODAY AND PROGRAMMED HOT SPARKS TOMORROW. A SURVEY OF ELECTRONIC IGNITION SYSTEMS AND A LOOK AT FUTURE TRENDS**

The use of electronic ignition systems in automobiles is discussed. Transistorized ignition systems retain the conventional coil, distributor, and contact breaker, but include a transistor unit inserted between the coil and the breaker points, creating transistor-assisted spark timing. While transistorized ignition greatly improves point life and high-speed spark performance, it has little effect on fouled-plug firing ability and plug life. The capacitor is a solid-state energy storage unit which replaces the condenser and discharges into the coil. The spark timing current is transistorized. The capacitor discharge permits the use of a pulse transformer instead of an induction coil as a spark generator, provides about 35% higher voltage than conventional systems, and delivers it in one-fifth of the normal time. This effectively eliminates bleed-off, which is the usual reason why dirty, fouled, or leaky sparkplugs fail to fire. The contact breaker mechanism can be replaced entirely by one of several devices, all suitable for use with capacitor or inductive discharge. The breakerless ignition system takes over the spark timing function, but has nothing to do with spark generation. The following different families of breakerless ignition have been developed and are currently

in use: the magnetic pulse generator; the metal-proximity detector; and the light-actuated pickup. Breakerless ignition systems which are installed as standard equipment by various domestic and foreign automobile manufacturers include: Delco-Remy High-Energy Ignition; Chrysler electronic ignition; Motorcraft solid-state ignition; Prestolite Breakerless inductive ignition; Bosch TSZ breakerless ignition; and Lucas oscillating pickup system. These current systems have eliminated a number of annoying ignition system problems and minimized fuel waste through misfiring. What remains to be done is to optimize the spark for emission control.

by Jan P. Norbye

Publ: Road and Track v27 n8 p137-42 (Apr 1976)

1976

Availability: See publication

HS-018 646

# **MULTIDISCIPLINARY ACCIDENT INVESTIGATION. GMC SCHOOL BUS/GM TRUCK "T" TYPE COLLISION**

The investigation of an accident involving a 1972 General Motors Corporation 5500 Chassis Blue Bird school bus and a 1976 Chevrolet one ton flat bed truck is reported. The truck was travelling west on a paved country road at an estimated speed of 55 mph. The school bus was east bound carrying 55 passengers and making a left turn into a school lot at an estimated speed of 5 mph. The driver of the truck applied his brakes, resulting in the truck sliding in front of the turning bus and being hit directly on the left side. Both vehicles came to rest facing north at the north edge of the road with the rear of the bus extending across the highway. The driver of the truck and 15 bus passengers received minor injuries (Accident Severity Injury Level I). The truck was damaged beyond repair, while the bus was repaired at a cost of 2,500 dollars. The principal cause of the accident was found to be the failure of the driver of the bus, who was preoccupied with checking the rear view mirror, to observe the approaching truck. Factors which increased the severity of the accident included the lack of seat belts on the bus, excessive tar on the roadway which reduced the co-efficient of friction, and loose lumber on the truck, which caused shattered windows and intrusion into the bus. The evasive action of the truck driver and the low closing impact speed contributed to the reduction of the severity of the accident. In addition, padding along the top of the seat backs and stanchion rails may have been effective in reducing injuries. Photographs of the accident, the occupant seating arrangement, details on each of the vehicle occupants, and details of vehicle collision performance and of passenger injuries are included.

Transport Canada (Surface), Accident and Defect Investigation Div., Ottawa, Ont., Canada  
Rept. No. DTS-107-75; 1975; 23pp

Includes French and English summaries.

Availability: Director, Road and Motor Vehicle Traffic Safety, Ministry of Transport, Ottawa, Ont., Canada

HS-018 647

# **MULTIDISCIPLINARY ACCIDENT INVESTIGATION. CHEVROLET SCHOOL BUS/DODGE SCHOOL BUS/REAREND COLLISION**

An investigation of a rearend collision involving a 1970 Chevrolet school bus and a 1970 Dodge school bus is reported. The Dodge bus had been stopped in its traffic lane to await an opportunity to overtake a highway maintenance truck and crew which was making road repairs. The Chevrolet bus approached the Dodge bus from the rear at a speed of about 45 mph and was unable to stop. After skidding about 76 feet, the Chevrolet bus collided with the rear of the Dodge bus. The force of the impact caused the passengers in the striking bus to be thrown violently forward, in many cases causing them to contact the seatbacks ahead of them. The passengers on the stopped bus experienced whiplash, which accounted for the majority of the injuries sustained. The overall injury severity level for the accident was AIS-2. The damage to the stopped bus was assessed at 2,000 dollars and the replacement cost of the striking bus was estimated to be 9,000 dollars. The rear emergency door of the stopped bus and the front right exit of the striking bus were jammed close by the collision, hindering evacuation from the vehicles. The most serious injuries to passengers of the striking bus resulted from contact with the exposed steel seatback rails. The whiplash experienced by passengers in the stopped bus might have been reduced if head restraints had been installed as part of the seatbacks. Air pressure loss in the braking system of the striking bus, which had not progressed enough to set the rear brakes, may have been a major contributing factor to the seriousness of the accident. The lack of seat restraints and the inability of the structural members of the seating systems to withstand the impact without bending or complete failure of some members may also have contributed to the injury severity level. Accident and occupant schematics, photographs of the site and the vehicles, and collision and injury and passenger information reports are provided.

University of New Brunswick, Vehicle Collision Study Team, Fredericton, N.B. Canada

Contract 98378

Rept. No. UNB-052-74; 1974; 140p

Includes French and English summaries. Prepared for the Director of Road and Motor Vehicle Traffic Safety, Ministry of Transport, Ottawa, Ont., Canada.

Availability: Director, Road and Motor Vehicle Traffic Safety, Ministry of Transport, Ottawa, Ont., Canada

HS-018 648

# **MULTIDISCIPLINARY ACCIDENT INVESTIGATION. SINGLE VEHICLE/OFF HIGHWAY/STRUCK A ROCK FACE CLIFF**

The investigation of an accident which occurred when the left front tire of a 1972 International Transtar model C04070 tractor with a semitrailer deflated, causing the driver to lose control of the vehicle is reported. The vehicle veered off the left side of the two lane undivided rural arterial highway, entered a ditch, and stopped striking upon the rock face back slope of the ditch. The driver sustained minor injuries to his right wrist during the collision. The vehicle was not equipped with a lap restraint system. The repair costs for the vehicle were \$15,000. The operator of the truck had never driven this particular tractor before this trip and had only about 6 hours of driving with it before the accident. The accident occurred on a wet road



during the early morning hours. There are no guardrail installed to direct vehicles away from the rock face. It is suggested that the mass of the vehicle probably contributed to the operator not receiving any serious injury, since most of the energy of impact was absorbed by the truck. Detailed descriptions of the accident and damage to the vehicle are included.

University of New Brunswick, Vehicle Collision Study Team,  
Fredericton, N.B., Canada  
Contract 98378  
Rept. No. UNB-053-74 ; 1974 ; 50p  
Includes French and English summaries.  
Availability: Director, Road and Motor Vehicle Traffic Safety,  
Ministry of Transport, Ottawa, Ont., Canada

HS-018 649

#### **MULTIDISCIPLINARY ACCIDENT INVESTIGATION. SINGLE VEHICLE/ROLLOVER TRACTOR- SEMITRAILER**

The operator of a 1974 Chevrolet J-90 series tandem-drive tractor with a flatbed semitrailer loaded with pulpwood was travelling in daylight on a dry, undivided rural collector highway, and as he approached a left curve he met a passenger car encroaching on his lane. The operator steered the truck to the right to avoid collision and then lost control of the vehicle, causing it to jack-knife and overturn in a ditch. The operator was using his lap belt restraint at the time and escaped with only minor injuries. Causal factors for the accident are discussed and an accident schematic and photographs of the damaged vehicle and the accident scene are provided. Human, vehicle and environmental factors for the pre-crash, crash and post-crash phases are considered and a complete collision performance and injury report form for the truck and tabulated skid resistance readings are provided.

University of New Brunswick, Vehicle Collision Study Team,  
Fredericton, N.B., Canada  
Contract 98378  
Rept. No. UNB-057-74 ; 1974 ; 48p  
Includes French and English summaries.  
Availability: Director, Road and Motor Vehicle Traffic Safety,  
Ministry of Transport, Ottawa, Ont., Canada

HS-018 650

#### **MULTIDISCIPLINARY ACCIDENT INVESTIGATION. 1974 GMC 1/2 TON PICKUP/RAN OFF ROADWAY/FIXED OBJECT COLLISION**

A full report of a single-vehicle accident involving a 1974 General Motors pick-up truck which failed to negotiate a curve on an urban street. The truck sideswiped a steel mesh fence and collided with and came to rest against the heavy steel cornerpost. The major causation factors of the collision are seen to be the slippery roadway condition and the strong possibility of driver alcohol impairment. None of the three occupants were restrained during the collision and all received minor or moderate injuries, consisting mostly of cuts and abrasions from contact with the windshield and instrument panel. The vehicle was damaged beyond economic repair. The following information is provided: a case summary; a listing of accident event causal factors; an accident schematic; photographs of the vehicle and accident site; a description of human, vehicle and environmental factors in the pre-crash, crash and post-

crash phases; and a complete collision performance and injury report form.

University of New Brunswick, Vehicle Collision Res. Team,  
Fredericton, N.B., Canada  
Contract 100494  
Rept. No. UNB-058-75 ; 1975 ; 71p  
Includes French and English summaries.  
Availability: Director, Road and Motor Vehicle Traffic Safety,  
Ministry of Transport, Ottawa, Ont., Canada

HS-018 651

#### **MULTIDISCIPLINARY ACCIDENT INVESTIGATION. 1974 INTERNATIONAL/1974 BUICK/SIGNAL STANDARD/REAREND/1974 PONTIAC/1972 CAPRI/SIDESWIPE/1968 FALCON/INTERSECTION "T" TYPE**

A full report of a five-vehicle accident is presented. A 1974 International Transtar tractor pulling a loaded semi-trailer was westbound on a major urban arterial. The truck was unable to stop at a signalized intersection, collided with the rear of a 1974 Buick Century and sideswiped a 1974 Pontiac, which were stopped at the lights. The truck pushed the Buick through the intersection. While passing through the intersection, the truck was struck at the right fuel tank by a 1968 Ford Falcon. The Buick and truck came to rest in the left lane of the opposing traffic after having struck a signal standard. The Pontiac slid sideways and struck a 1972 Capri which was stopped in the adjacent lane. The driver of the Buick was the only injured occupant. The main causal factor was the malfunctioning of the truck's brakes due to show between the brake shoes and the drums. The following information is provided: a case summary; descriptions of the pre-crash, crash and post-crash phases; a listing of the causal factors; an accident schematic; photographs of the vehicle damage and the accident site; a description of the human, vehicle, and environmental factors of the pre-crash, crash and post-crash phases; a driving history of the truck driver; a psychological interview with the driver of the Buick; and complete collision performance and injury forms for the truck, the Buick and the Pontiac.

University of Saskatchewan, Vehicle Accident Study Team,  
Saskatoon, Sask., Canada  
Contract 96101  
Rept. No. UOS-044-75 ; 1975 ; 131p  
Includes French and English summaries.  
Availability: Director, Road and Motor Vehicle Traffic Safety,  
Ministry of Transport, Ottawa, Ont., Canada

HS-018 652

#### **MULTIDISCIPLINARY ACCIDENT INVESTIGATION. KENWORTH SEMI-TRAILER/OLDSMOBILE CUTLASS/TYPE "L" INTERSECTION/KENWORTH SEMI-TRAILER/NOVA/TYPE "T" INTERSECTION/NOVA/LIGHT STANDARD/FIXED OBJECT**

A full report of a three-vehicle accident is presented. The driver of a 1962 Kenworth Canadian tractor and loaded semi-trailer was proceeding on a major four-lane limited access highway at about 40 mph. As he approached a signalized intersection at the end of the highway, the truck's brakes malfunctioned and the truck went into the intersection against a red

light. The truck struck the right rear fender of a 1974 Oldsmobile sedan and the broadside of a 1973 Chevrolet Nova which were traveling through the intersection on a green light. The truck driver was uninjured. The driver and passenger of the Oldsmobile received minor injuries and were released from the hospital after examination. The driver of the Nova was knocked unconscious upon impact and received whiplash injuries to her neck. She was also released from the hospital after examination. The Nova was damaged beyond economic repair. The following information is provided: a case summary; descriptions of the human, vehicle and environmental factors of the pre-crash, crash, and post-crash phases; an accident causation listing; seat belt use; an accident schematic; photographs of the vehicle accident damage and the accident scene; results from psychological interviews with the driver of the Oldsmobile and Nova; and complete collision performance and injury report forms for the truck and the Oldsmobile. It was determined that, due to aging, the line to the activation side of the trailer brakes on the truck developed a leak and caused brake failure on the trailer portion of the unit. The accident damage costs were determined to be: \$500 for the truck; \$1000 for the Oldsmobile; and \$2600 for replacement of the Nova.

University of Saskatchewan, Transportation Centre,  
Saskatoon, Sask., Canada  
Contract 96101  
Rept. No. UOS-048-75 : 1975 : 105p  
Includes French and English summaries.  
Availability: Director, Road and Motor Vehicle Traffic Safety,  
Ministry of Transport, Ottawa, Ont., Canada

HS-018 654

## **INFLUENCE OF ROAD SPEED RESTRICTIONS ON THE INCIDENCE AND SEVERITY OF HEAD INJURIES**

A comparative survey has been made of patients with head injuries admitted to Tiervlei, South African, hospitals during six month periods in 1973 and 1974, before and after the introduction of fuel-saving measures, including speed restrictions. Substantial decreases in severity (a relative mortality rate drop of 6%, poor recovery rate lowered by 6.3%, fair recovery by 8.3%, and a good recovery rate increase of 20.6%) and incidence (from 180 cases of traffic accident head injury in 1973 to 143 in 1974, a 20.6% decrease) of injury were discovered. It is concluded that the main cause of the improvement has been reduced traffic speeds. A plea is made that they be permanently maintained.

by A. P. Rose-Innes; C. J. G. Le Roux  
Publ: South African Medical Journal v48 p2548-51 (14 Dec 1974)  
1974 : 6 refs  
Paper presented at the South African National Neurosurgical Congress (3rd) Cape Town, 23 Sep 1974.  
Availability: See publication

HS-018 655

## **THE EFFECT OF MEDAZEPAM AND ALCOHOL ON COGNITIVE AND MOTOR SKILLS USED IN CAR DRIVING**

Questionnaires, motorskill and cognitive tests were given to three groups of 12 healthy young men after administration of either 0, 10, or 20 milligrams of medazepam (Nobrium). Tests

were given both before and after experimental intoxication with 1 milliliter per kilogram bodyweight of diluted ethanol. On most tests medazepam did not interact with alcohol; no synergistic or antagonistic drug reaction was observed. A greater subjective fatigue rating by the drug groups was not confirmed by objective measures. The use of psychoactive drugs with ambulant patients is discussed and it is concluded that medazepam medication has no detrimental effect on driving ability. Complete experimental results are tabulated.

by Ali A. Landauer; Derek A. Pocock; F. W. Prott  
Publ: Psychopharmacologia v37 p159-68 (1974)  
1974 : 13 refs

Research supported by a University of Western Australia Research Grant and by Roche Products Proprietary Limited. Prepared in cooperation with the Public Health Lab. Services and the Dept. of Police.  
Availability: See publication

HS-018 656

## **A PHYSIOLOGICAL MATH MODEL FOR HUMAN VISUAL TARGET DETECTION**

A basic mathematical model of the retina predicting the liminal contrast required to detect a target as a function of target size, background brightness and exposure time is presented. A photo-receptor response function with the customary logarithmic behavior at high luminance levels and the necessary linear behavior at low luminance levels is also presented. This response function, and the premise that target detection occurs when the difference in response of cells across a target/background contour is greater than some threshold, are the basic parts of the model. A logical wiring diagram for the retina is conceived which resembles the actual anatomy of the retina and seriously considers the hypothesis that bipolar cells respond to the difference of two photoreceptor cells. The photoreceptor response function and the structure of the model allow the development of a mathematical expression for threshold contrast as a function of background brightness. The pupil is included in the model and is treated as a transmission filter which passes light flux in proportion to its area. The threshold contrast equation with pupil factor included is fit to psychophysical data. Only two points on each empirical curve of threshold contrast versus background brightness are required to evaluate the model's sensitivity parameter and threshold parameter. The resulting theoretical equation for threshold contrast is shown to accurately fit the experimental data.

by Arthur Bernstein  
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1977 : 32p 11 refs  
Availability: Corporate author

HS-018 657

## **EVALUATION OF AN ACCELERATOR POSITION SIGNAL**

Driving simulator and road tests were conducted to evaluate an accelerator position signal (APS) on the rear of motor vehicles. The signal was provided by a green lamp when the accelerator was depressed, a yellow lamp when the accelerator was released and a red lamp, in addition to the usual stop lamps, when the brakes were applied. The system augmented the conventional rear lighting system. Driving simulator studies

with 10 subjects showed no benefits of the signal in increasing the detectability of stop or turn signals. No reliable benefits were found in measures of car-following performance, either in normal car-following conditions or in unusual, emergency conditions. A driving test conducted to evaluate the responses of other motorists exposed to the system on a two lane road, showed that they tended to coast in response to the first exposure to the yellow coasting signal, but did not respond to a second exposure. A one minute evaluation of motorists' car-following performance did not show significant reductions in headway and relative velocity standard deviations with the APS compared to the conventional system. Drivers in a structured experiment (14 female and 6 male drivers in five driving conditions) rated the APS favorably, but their ratings were insensitive to a programmed change in testing conditions and were considered to lack validity. Drivers increased the frequency of release of the accelerator when following the car with the APS compared to the conventional system. It was concluded that only minor benefits were attributable to the APS whereas the signal produced unnecessary accelerator releases by the following car driver which would ostensibly propagate through a queue, add visual noise, and potentially lead to disturbances in the traffic flow.

by Rudolf G. Mortimer; Samuel P. Sturgis  
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Champaign, Ill. 61820; University of Michigan, Hwy. Safety  
Res. Inst., Ann Arbor, Mich. 48105  
Contract DOT-HS-031-3-723

1976; 33p 10cfs

Presented at the Annual Meeting of the Transportation Res.  
Board, Washington, D.C., 22 Jan 1976. Prepared in  
cooperation with C. D. Moore, Jr., C. M. Jorgeson, B. Abbott,  
and J. D. Campbell.  
Availability: Corporate author

HS-018 658

## A REVIEW OF VEHICLE DESIGN TO REDUCE ACCIDENTS

A survey of the literature on vehicle design factors related to the occurrence of accidents showed that little is known of this relationship. Design factors which have a known relationship to accident occurrence include such vehicle performance factors as acceleration capability, power to weight ratio, and speed; braking systems and capability; tires; vehicle visibility, including daytime running lights, reflecting surfaces, and vehicle color; rear vision systems; windshield construction and materials; mud flaps; steering and handling characteristics; and wheel design. The review indicates that the following improvements to vehicle design would reduce the occurrence of accidents; fitting of anti-skid devices to all vehicles; compulsory changing of tires when tread depth reaches one sixteenth of an inch; improvements in vehicle visibility; and fitting of efficient mud flaps on all wheels of a vehicle. There is also extensive literature on "implied safety." It is based usually on sound principles of safety and ergonomics, although there is no empirical relationship to safety at the present time. Frequently the particular design feature has not yet been adequately tested in production vehicles. These design factors which should improve safety include such modifications as polarized headlights, reflective surfaces, better brake systems, electronic

systems to automatically control vehicle guidance, better rear vision systems, and improved tires.

by E. R. Hoffman  
University of Melbourne, Dept. of Mechanical Engineering,  
Australia  
Rept. No. NR/7; 1973; 169p 163refs  
Cover title: A Review of Vehicle Design to Reduce Accidents  
in Relation to Road Safety. Prepared for the Australian Dept.  
of Transport.  
Availability: Corporate author

HS-018 659

## EFFECTS OF TREAD PATTERN DEPTH AND TYPE [TIRE] GROOVING ON LORRY [TRUCK] TYPE SKIDDING RESISTANCE

Two investigations were conducted to evaluate the wet road grip of truck tires. The first study investigated the effect of tread wear by examining the loss in wet tire/road skidding resistance at progressive stages of tire wear. Five tires were tested, including four highway service tires and one dual purpose tire. The characteristic initial loss in grip with wear similar for the four highway service tires, but the dual purpose tire, due to a rapid loss of drainage in the center of the tread area in the early stages of wear, showed a relatively greater loss in wet grip. In the second experiment, the effect of varying the ratio of the groove to rib width in a longitudinally straight grooved tire was examined for several numbers of ribs. The optimum ratio was found to be around 0.4 for the numbers of ribs tested. Tires with three, five, and seven ribs were investigated. The wet skid resistance was found to be more affected by the number of grooves available than by the groove/rib ratio, suggesting that even larger numbers of grooves than tested in this experiment would increase the grip still further. Complete test data are tabulated and diagrams of groove rib ratios on various tire sections are provided.

by T. Williams; J. K. Meades  
Transport and Road Res. Lab., Safety Dept., Crowthorne,  
Berks., England  
Rept. No. TRRL-LR-687; 1975; 60p 5refs  
Availability: Corporate author

HS-018 660

## AUTOMOBILE TIRES

A general history of automobile tires and a review of the different types of tires available today are presented. Pneumatic tires were first patented in 1845, but did not come into general usage until about 1910. Prior to this, they were considered highly desirable, but lacked the reliability for satisfactory performance. Until 1908, tires had no pattern in the tread area. Major technical changes in tire engineering which occurred in the 1913 through 1926 period included the standardization of the tire's profile to the straight-side design; the introduction of cord-type plies, which improved tire carcass durability and decreased rolling resistance significantly; and the development of the balloon tire. Although there were many changes in the materials used, there was little further change in basic tire design until the introduction of tubeless tires in 1954. Evolutionary changes to the present involve additional improvements in materials, the introduction of belted tires, and the gradual conversion to radial-ply tires. The three basic types of tires in passenger car use today are the bias-ply, the belted bias-ply, and the radial-ply. Tires are made from three basic

materials: rubber, fabric, and metal. Tires for passenger cars today come in three ply types, ten basic sizes, three rim diameters, five aspect ratios, three sidewall types, three basic tread types, and three load ranges. They are manufactured in a wide variety of combinations of these factors. Each size and type must be engineered for specific vehicles and service conditions. Tire manufacture involves the preparation of various rubber formulations and beads and cord fabrics for use in the tire, assembly of the tire by a skilled operator on a tire-building machine, and sophisticated uniformity and grading checks prior to sale.

by Larry Givens

Publ: Automotive Engineering v84 n1 p38-47 (Jan 1976)  
1976

Prepared in cooperation with Firestone Tire and Rubber Co.

and Goodyear Tire and Rubber Co.

Availability: See publication

HS-018 661

## BETTER AUTOMOTIVE LIGHTING IS COMING

A variety of improvements in lighting systems for automobiles can be expected during the next several years. Rectangular headlights will appear on a select group of 1975 U.S. cars, and will probably appear on more cars in 1976. It has been proposed that the maximum permitted output of U.S. headlamps be increased from 75,000 to 200,000 candela and that side turn signals be required on all passenger cars, multipurpose passenger vehicles, trucks, and busses. The use of rectangular headlamps provides a number of advantages related to the reduced headlamps height. The use of three-beam headlighting systems which would provide an intermediate beam furnishing an improvement in seeing distance as compared to lower beam lighting, but without the high intensity disadvantages associated with upper beams, has been proposed. The use of higher intensity upper beams has also been proposed, and is now possible due to improvements in efficiency making it possible to increase the light output without having to provide additional generating capacity. Daytime front running light systems are being developed which would utilize a second filament in the upper beam unit of a four-unit headlighting system, burning the upper beam filament of the type 2 unit at a reduced voltage, or running the regular upper beam filaments in series.

Publ: Lighting Design and Application v5 n10 p40-2 (Oct 1975)  
1975

Availability: See publication

HS-018 662

## TEXTURE, SKID RESISTANCE, AND THE STABILITY OF AUTOMOBILES IN LIMIT MANEUVERS

The capability of conventional automobile/tire systems to perform a variety of emergency maneuvers was determined. In general, this capability was quantified in terms of the maximum values of longitudinal and transverse vehicle accelerations that could be produced under specific conditions. These vehicle/tire performance measurements are compared directly with common indicators of available friction such as texture measurements and skid numbers. The texture measurements appear to correlate as well with vehicle performance as do direct friction measurements such as skid numbers and British

Pendulum Numbers. The work done for this particular study at the Texas Transportation Institute is part of a national research program devoted to refining the concepts and analytical tools needed to provide design criteria for pavement surfaces from the tire-pavement friction standpoint. The effects of vehicle speed and surface texture on the development of acceleration (or average developable friction) boundaries for a spectrum of automobile/tire systems was studied and it was found that the texture values correlated as mentioned above.

by G. G. Hayes; D. L. Ivey

Publ: American Society for Testing and Materials Special Technical Publication n583 p127-42 (1975)

1975 ; 12refs

Presented at a Symposium held in Washington, D.C., 23-28

Jun 1974. Includes a summary of all papers in the proceedings.

Availability: See publication

HS-018 663

## PAVEMENT SURFACE INFORMATION NEEDS IN ACCIDENT INVESTIGATION

A variety of information on pavement surface characteristics is needed for in-depth multidisciplinary traffic accident investigation (MDAI). MDAI teams established by the National Highway Traffic Safety Administration investigate vehicular collision events with regard to human, vehicle, and environmental factors as they relate to the pre-crash, crash, and post-crash phases of the specific accident event. The MDAI teams are specifically interested, when skidding type vehicular collision events occur, in estimating the pre-crash and at-crash velocities of involved vehicles on the basis of field evidence and any known pertinent characteristics of the vehicles, tires, and roadway surfaces. Tire-pavement interface friction estimates utilized in speed estimation are key items in accident reconstruction. Such research as that leading to the empirical determination of effects of hydroplaning variables on skid resistance are of immediate value to accident investigators. Combined cornering and braking experiments should not all be designed solely to serve the braking stiffness, cornering stiffness, and lateral stiffness data needs of the vehicle dynamics specialists' mathematical models; Gough plots designed for extrapolation to accident site specific conditions are needed by accident investigators. Heightened interest in the development of tools and information specifically for accident analysis and reconstruction purposes would greatly help to advance the cause of traffic safety.

by J. W. Hutchinson; N. G. Tsongos; R. C. Bennett; W. J. Fogarty

Publ: American Society for Testing and Materials Special Technical Publication n583, p116-26 (1975)

1975 ; 15refs

Presented at a Symposium held in Washington, D.C., 23-28 Jun 1974.

Availability: See publication

HS-018 664

## STARTLE REACTION TO AIR-BAG RESTRAINTS

The startle effect resulting from unexpected deployment of a steering-wheel-mounted air cushion on unsuspecting drivers was investigated with 51 drivers. Blood-pressure changes, pulse rate changes, electrocardiographic (ECG) changes, and galvanic skin reaction (GSR) were used as measures of the intensity of this physiological response. The physical and

physiological responses to hood fly-up were compared to those of air cushion deployment. All drivers were tested seated in the driver's seat of a standard 1973, four-door sedan and drove a circuitous route at speeds varying from 25 to 45 mph. Braking pressure, lane deviation, and steering-wheel rotation reactions during hood fly-up and air cushion deployment were recorded, together with the physiological responses. The tests demonstrated that startle is a measurable response to unexpected events and that both the physical and physiological responses to startle can be quantitated by various methods easily instrumented in a test vehicle. Findings from monitoring of ECG, pulse rate, blood pressure, and GSR support the concept that both air-cushion deployment and hood fly-up produce physiological changes caused by the startle phenomenon and that air-cushion deployment is apparently only minimally more startling than hood fly-up. Under the experimental conditions, although there was considerable physiological evidence of the startle phenomenon, drivers retained good control of the test vehicle and were lucid on questioning less than 10 seconds after cushion deployment. All drivers with hood fly-up or cushion deployment were easily able to see to guide their car in spite of the minimal obstruction of vision produced by the event. Audiometric examinations performed before and after the test on 36 of the drivers showed no change in hearing acuity resulting from the noise on deployment of the air cushion.

by H. Haskell Ziperman; George R. Smith  
 Publ: Journal of American Medical Association v233 n5 p436-40 (4 Aug 1975)  
 1975 ; 5refs  
 Availability: See publication; H. Haskell Ziperman, Southwest Research Institute, 8500 Culebra Rd., San Antonio, Tx 78284

HS-018 666

## MANUAL ON ALCOHOLISM OF THE AMERICAN MEDICAL ASSOCIATION

The nature of the problem of alcoholism, the causes of alcoholism, the metabolism and pharmacology of alcohol, and the diagnosis and treatment of alcoholics are explored. Alcoholism is defined as an illness which is characterized by preoccupation with alcohol and loss of control over its consumption. Alcoholism is seen as a type of drug dependence of pathological extent and pattern, which ordinarily interferes seriously with the patient's total health and adaptation to the environment. The illness is not limited to any particular class, group, or area. The goal of every treatment program should be to help the alcohol-dependent patient learn to deal effectively with his life problems without using the drug and to adapt to his environment in a reasonably mature manner. Most authorities agree that there is no single cause of alcoholism, but rather that a complicated interplay of physiological, psychological, and sociological factors leads to the origin and development of alcoholism. Diagnosis and effective treatment of the alcoholic require consideration of the relative importance and applicability of those causative factors which are most pertinent in the particular instance. Diagnosis must include a thorough history, physical examination, and laboratory studies. Many patients will require both treatment of physiological conditions and psychiatric treatment. Continuing

the alcoholic readjust to society after treatment of acute alcohol-related problems.

American Medical Assoc.  
 1968 ; 93p  
 Availability: Corporate author

HS-018 669

## DRIVERS' PHYSIOLOGICAL REACTIONS AND CONTROL OPERATIONS AS INFLUENCED BY TRAFFIC EVENTS

The influence of traffic events on the driver's activation level and vehicle control operations was investigated during experimental tests on rural roads. During test runs, psychophysiological variables from the drivers were registered together with variables describing the dynamic behavior of the vehicle and a description of the traffic events. All measured values were stored on a digital tape recorder and processed in a computer. The driver's physiological activation was studied through electrodermal response (EDR) and heart rate (HR). Muscle potentials from two muscles in the right leg were also registered with electromyography (EMG). The velocity of the car and the road length were measured using a digital counter mounted on the left rear wheel. Other vehicle variables which were measured included acceleration, steering wheel angle, and brake pressure. The traffic was described using a key board on which the experimenter encoded traffic events. The tests indicated that, from the ergonomic point of view, measuring driver's adaptation or perceived task difficulty, EDR appears to be the most valid of the measures employed, considering the covariation with the brake pressure. A tendency on the part of the driver to steer to the left when opposing cars pass by was noted. It is concluded that significant relationships exist between the complexity of traffic events, the driver's activation level, and the driver's control operations.

by Martin Helander  
 Publ: Zeitschrift fur Verkehrssicherheit v20 n3 p174-87 (1974)  
 1974 ; 20refs  
 Includes summaries in German, French, and English.  
 Availability: See publication

HS-018 670

## LEAN MIXTURE ENGINES TESTING AND EVALUATION PROGRAM. VOL. 1. EXECUTIVE SUMMARY. FINAL REPORT

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 Contract RA-74-38-TMP-0223  
 Rept. No. DOT-TSC-OST-75-26.1; JPL-5040-12-Vol-1 ; 1975 ; 31p 8refs  
 Report for 28 May 1974-31 Dec 1974. For abstract see vol. 2 HS-018 671; and vol. 3, HS-018 672.  
 Availability: NTIS

## LEAN MIXTURE ENGINES TESTING AND EVALUATION PROGRAM. VOL. 2. COMPREHENSIVE DISCUSSION. FINAL REPORT

The potential of the lean-burn concept in the areas of fuel economy and exhaust emissions was investigated. A literature search was conducted which documented the concept that improved fuel economy and reduced exhaust emissions are inherent advantages of lean-mixture operation of gasoline engines. The effects of various engine factors and fuel mixtures on engine operation were investigated. Engine dynamometer and chassis dynamometer fuel consumption and emissions data were developed for both the baseline 1973 Chevrolet V-8, 350 cubic inches displacement engine and for the two lean-burn engine configurations tested. The effects of combustion duration, compression ratio, and cylinder-to-cylinder maldistribution on engine performance were investigated. The cylinder-to-cylinder distribution of equivalence ratios was evaluated from exhaust gas composition measurements from individual cylinders. Information regarding ignition delay, combustion duration, and cycle-to-cycle pressure variations was obtained based on pressure-time traces from individual cylinders. These tests successfully demonstrated that operating engines with a lean mixture can provide significant improvements in fuel economy over the stock engine. It is concluded that the lean burn concept combined with catalytic converter has the potential for significantly improving fuel economy over the emission-controlled stock engine while producing emissions consistent with the interim 1977 emissions standard. Considerable data from the engine tests are included.

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Contract RA-74-38-TMP-0223  
Rept. No. JPL-5040-12-Vol-2; DOT-TSC-OST-75-26.II; 1975;  
119p 44refs  
Report for 28 May 1974-31 Dec 1974. Vol. 1 (Executive  
Summary) is HS-018 670; vol. 3 is HS-018 672.  
Availability: NTIS

## LEAN MIXTURE ENGINES TESTING AND EVALUATION PROGRAM. VOL. 3. APPENDICES. FINAL REPORT

The potential of the lean-burn concept in the areas of fuel economy and exhaust emissions for gasoline engines was investigated through the collection and analysis of experimental operating data using a stock 350 cubic inch displacement 1973 Chevrolet V-8 engine and two experimental lean-burn engine configurations. Significant cycle methods and analysis methods for the prediction of engine emissions and performance characteristics are identified. Data for the stock baseline engine and sensitivity test data for the two lean-burn engine configurations utilized in these experiments are presented. Mapping test data and pressure-time data for the second lean-burn experimental engine configuration tested are also included. The instrumentation capability for the engine test program was based on a digital data acquisition system that contains a capacity large enough to allow real-time output of not only engineering units data, but also key calculated parameters. The key parameters used to facilitate engine testing in these investigations were: gasoline mass flow; air mass flow;

equivalence ratio; thermal efficiency; and emission ranging and linearization.

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Contract RA-74-38-TMP-0223  
Rept. No. DOT-TSC-OST-75-26.III; JPL-5040-12-Vol-2  
82p

Report for 28 May 1974-31 Dec 1974. Vols. 1 and 2 are  
670 and 018 671.

Availability: NTIS

## ON AND OFF-BOARD BRAKE SYSTEM MONITORING STATUS AND PROSPECTS FOR THE FUTURE

The present state-of-the-art of monitoring passenger car brake systems using on-board sensors and the development of a more comprehensive off-board monitoring system are described. Automotive brake systems are currently being monitored by a brake warning light on most automobiles which indicates gross problems in the areas of brake pedal reserve, master cylinder condition only. The two basic categories of brake wear sensors which predominate on the automotive market at present are an audible (mechanical) on-board sensor and electrical sensors, which may provide for either direct reading or indirect reading. Current methods for determining the status of brakes include off-board performance tests, periodic static brake inspection, neither of which are suitable for frequent inspections. Avco Systems Division is currently developing a static inspection technique which can be used during periodic motor vehicle inspections to determine the condition of brakes. The method being developed involves visual wear indicators and access ports to make the status of the brake system apparent with a fast and positive inspection. Preliminary testing and experimentation with the system was carried out on a 1974 Pontiac LeMans, a 1974 Pontiac Astre (Vega), and a 1971 Ford LTD. Visual access ports are used to show the wear condition of discs, drum linings, and leakage of wheel cylinders without removing the wheels. Vehicle specifications, data banks, or measuring tools are not necessary to enable direct viewing of visual wear indicators, brake parts, and hub or axle seals, with the aid of a mirror, and to route wheel cylinder leak indicators to the off-board area of the brake area. Each drum requires a minimum of one access port. The use of either electrical on-board sensors or off-board system being developed by Avco would require no vehicle modifications, but would contribute significantly to safety and would reduce maintenance cost, since brake linings could be detected before damage was done to the brake system.

by Thomas H. Forman; William Lemeschewsky  
AVCO, Systems Div.  
Rept. No. SAE-750875; 1975; 12p 4refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

## THE FREQUENCY OF ROAD ACCIDENTS (E)

An attempt has been made to determine the manner in which

of travel for any given time of day varies. The accidents occurring in any location in any periods on such factors as the climate, the traffic conditions of vehicles in use, and the behavior of the The "constants" of the proportionality for having only cars and goods vehicles have been he years, those for two-vehicle accidents falling ipidly than those for single-vehicle accidents. The or accidents involving two-wheeled vehicles only d rather more uniform, and, in some cases, have onstants" for accidents involving cars or goods :wo-wheeled vehicles have all been falling, but at rate than those involving cars and goods vehi- a number of pedestrian accidents in any daylight a be approximately proportional to the product of travelled by the vehicles in that hour and the edestrians crossing the road in that hour. The of the proportionality for car and goods vehi- n accidents have been falling over the years, but l little for motorcycle/pedestrian accidents. Acc- nd accident severity are tabulated for 1961, 1965, ce there are a number of known ways in which s and fatalities may be reduced and these are l in any country, it is suggested that the number ities in any country may be regarded as the id deaths that the country is prepared to tolerate. : formula is developed by which the number of ntry is prepared to tolerate is approximately

Smeed

ift fur Verkehrssicherheit v20 n3 p151-9 (1974)

naries in German, French, and English.

See publication

## CHARACTERISTICS OF HIGH-DRIVERS OVER A FIVE-YEAR PERIOD

ion of the characteristics of drivers in Indiana olved in at least five accidents over the 5 year 967 through 1971 was conducted. Data were col- groups of drivers: the first group included all were identified as being involved in three or ts during the year 1967, forming the high-accident e second group, which was the control group, a random selection from all Indiana drivers. The who were found to have been involved in at least ts during 1967 were also found to have been in- otal of 9,269 reported accidents over the 5-year ig from a low of three, all in 1967, to a high of 29 cen as a group, it is clear that the accident record 4 drivers underwent much improvement during od following the 1967 base year. A large propor- drivers who are involved in three or more ac- ; a particular year were found to remain accident- e following four years. Nearly all of the high-ac- s were male. Drivers with chauffeur's licenses, ly public passenger chauffeur's licenses, account roportion of the individuals who were high ac- s during one year and continued to be high-ac- s during the following years. High-accident- found likely to be residents of large urban areas. record of a driver who has a high-accident in- ring a particular year was found to have little

relationship to the driver's accident record in the following years. In general, the accident record of a driver during one year, even when combined with information available in the Indiana drivers' records, did not enable a reasonable prediction of the driver's accident record for future years. In very few cases, where a history of numerous violations and accidents are recorded, can a reasonable prediction of continued high-accident involvement possibly be made.

by John E. Goodson; Harold L. Michael

Purdue Univ., Joint Hwy. Res. Proj.

Publ: Purdue University Engineering Reprints, n.p., 1975 p193-214

Rept. No. CE-301 ; 1975 ; 13refs

Availability: Corporate author

HS-018 676

## AIR POLLUTION CONSIDERATIONS IN TRAFFIC PLANNING AND ENGINEERING

A significant part of air pollution control strategy can be achieved through effective traffic engineering measures. Air pollution associated with automobile transportation consists mainly of carbon monoxide, nitrogen oxides, hydrocarbons, lean compounds, suspended particulates, and some sulfur oxides. Under the existing circumstances, where the effective control of automobile air pollution immediately at the source is not technologically or economically feasible, the emphasis should be placed on an improved traffic management program or better traffic planning and design. This should also include control of land use so that the indirect sources that attract automobile traffic in large numbers, and contribute to the degradation of the air quality of an area, can be regulated. One feature of a complete air quality maintenance plan would involve the determination of whether or not a large, indirect source of pollution, such as a parking facility, would adversely affect the ambient air quality standards. Highest concentrations of carbon monoxide occur near exit/entrance gates of a parking lot, at nearby intersection approaches to the lot, and in the vicinity of access roads. Long range planning and control strategies include proper arrangement of land uses and laying out new streets and buildings to minimize air pollution effects. Land use-transportation planning will also make it possible to develop transportation systems which minimize the amount of vehicular traffic and the length of trips. Short-term and intermediate-range traffic engineering actions which can be undertaken in existing urban areas to reduce air pollution from automobiles include: reverse lane operations and ramp control on freeways; widening intersections, using reversible lanes and one-way streets, and signal progression on arterial roads; and traffic responsive control, loading regulations, and one-way street operations in downtown areas. Techniques for reducing traffic volume in urban areas include: improved transit operations, including bus lanes and service improvement; regulations such as parking bans and idling restrictions; and gasoline or road user taxes and taxes on engine size.

by Kumares C. Sinha

Purdue Univ.

Publ: Purdue University Engineering Reprints, n.p., 1975 p159-72

Rept. No. CE-302 ; 1975 ; 8refs

Availability: Corporate author

HS-018 677

## TRAFFIC SPEED REPORT NO. 95. INTERIM REPORT

A continuing study of speeds of vehicles on Indiana highways is being conducted. Observations of spot speeds taken on interstate, four-lane, and two-lane highways throughout the state during the months of October and November 1975 are reported. All traffic observations were made of free-flowing vehicles on level, tangent sections of rural and urban highways during daylight and under favorable driving conditions. The observations were obtained by use of an "Electromatic" Radar Speed Meter. The overall average speeds for all vehicles and passenger cars in this study were found to be 57.4 mph and 57.8 mph respectively. The overall average speeds for heavy trucks and for all trucks were found to be the same and equal to 56.3 mph. These overall average speeds are 1.0 mph, 0.9 mph, and 1.1 mph less for all vehicles, passenger cars, and all trucks, respectively, than the results of observations made during July through September 1975. The reduction in the average speeds and the 1.6 mph reduction in the 85th percentile speed of passenger cars occurred primarily on interstate highways. It is suggested that the decrease in speeds can probably be attributed to an expanded speed enforcement program on the rural interstates which occurred during the period and which was well publicized.

by A. A. Gadallah; G. K. Stafford  
Joint Hwy. Res. Proj., Civil Engineering Bldg., Purdue Univ.,  
West Lafayette, Ind. 47907  
Contract HPR-1(12)-Part I  
Rept. No. JHPR-76-9; 1976; 28p  
Report for Oct-Dec 1975. Prepared in cooperation with the  
Indiana State Hwy. Commission and the Federal Hwy.  
Administration.  
Availability: NTIS

HS-018 678

## PRIORITIES IN THE IMMEDIATE CARE OF ROADSIDE AND OTHER TRAUMATIC CASUALTIES

The application of anaesthetic skills in a confusing accident situation is discussed. The unfamiliar and distracting surroundings of a serious accident may cause even an experienced anaesthetist to forget the priorities. The first task of the medical resourcer on arrival at the scene of an accident is to make a rapid assessment of each patient to establish an order of priority for treatment. Immediate care of the injured patient is founded on the basis of the following considerations: what should be done to preserve the life of the patient; what can be done to minimize the complications due to the injuries; and what can be done to reduce the pain from which the patient is suffering. In preserving life, the first actions must be: to ensure a clear and safe airway; to assess, and support if necessary, ventilation and oxygenation; to diagnose and treat, if necessary a pneumothorax; and to arrest hemorrhage and replace blood loss. These vital priorities have on occasion been overlooked in the face of other dramatic but less urgent injuries. The best way to avoid complications due to the injuries themselves is to remember what these complications may be and to be alert, not only for the obvious injury, but for the injuries that are hidden. The possibility of spinal or head injury should always be considered. Analgesia is all too often inadequate or even totally omitted at the accident site for pa-

humane benefits. In accident situations where both respiration and circulation are in jeopardy, the following factors should be considered in providing analgesia: the effectiveness of the analgesia; its depressant side effects; and its route of administration, uptake, and duration of action.

by Peter J. F. Baskett; John S. M. Zorab  
Publ: Anaesthesia v30 n1 p80-7 (1975)  
1975

Based on a chapter written for "Rescue--Emergency Care," and material presented at the European Congress of Anaesthesiologists (4th) Madrid, Sep 1974.  
Availability: See publication

HS-018 679

## SAFETY. INTERIM REPORT

A Federal Interagency Task Force consisting of representatives from the Federal Highway Administration, the Energy Research and Development Administration, the Environmental Protection Agency, the National Science Foundation, the Department of Transportation, and others was established to examine long-range energy goals for the motor vehicle fleet, compatible with environmental, safety, and economic objectives. The Safety Panel within the Task Force was directed to: evaluate the effects of different levels of vehicle safety characteristics upon highway accidents, injuries, deaths, and vehicle damage; assess the resulting social and economic benefits; and determine alternative methods of improving highway safety, including non-vehicle safety countermeasures. The Safety Panel established two levels of safety for crashworthiness and crash avoidance and one for damageability requirement in order to support benefit and vehicle design trade-off studies of possible passenger car safety countermeasures. Safety problem baseline characteristics were estimated for 1975 for use in determining the incremental benefits for the various crash avoidance, crashworthiness, and occupant protection improvements studied. Countermeasures which would either avoid accidents that are now occurring or reduce the severity of these accidents were examined for feasibility in automobile application, for their benefit-cost relationship, and for their effect on vehicle weight and other factors. Countermeasure benefits versus relative costs were examined individually and in combination with other countermeasures. The levels of safety established for this study provide a wide range of safety alternatives which might be realizable during the 1980's rather than representing safety countermeasures which are presently planned to be implemented during specific years.

Interagency Task Force on Motor Vehicle Goals Beyond 1980, Panel on Safety  
1976 ; 168p 57refs  
Prepared for the Energy Res. and Devel. Administration, Environmental Protection Agency, Dept. of Transportation, Federal Energy Administration, and National Science Foundation.

Availability: Office of the Secretary of Transportation, Publications Section, TAD-443.1, Washington, D.C. 20590

HS-018 680

## MARKETING AND MOBILITY. INTERIM REPORT

A model of automobile and travel demand is presented. The level and structure of consumer automobile travel demand are



ctions upon fuel consumption, vehicle miles of travel, and patterns of automobile usage is aggregated. The model is summarized as an inter-related sensitivity analysis of it is given.

Task Force on Motor Vehicle Goals Beyond 1980, Marketing and Mobility

the Energy Res. and Devel. Administration, Federal Protection Agency, Dept. of Transportation, Regulatory Administration, and National Science

Office of the Secretary of Transportation, Section, TAD-443.1, Washington, D.C. 20590

## ITY, NOISE AND HEALTH. INTERIM

of the air quality, noise and health implications year 2000 of a variety of separate scenarios dealing with pollutant and noise emission limits is presented. The scenarios involved a series of assumptions as to population impact, and future emission levels of major and minor light duty motor vehicles, all of which are based on findings. Only changes in levels of carbon monoxide, photochemical oxidants, and nitrogen dioxide (NO<sub>2</sub>), or which national ambient air quality standards developed, are considered. For all mobile sources with rates of one percent annually for CO and hydrocarbons (HC) and nitrogen oxides (NO<sub>x</sub>) were selected. Stationary source (electric generation, area sources, and other point sources) with rates of 3.2% annually for CO and HC and NO<sub>x</sub> were estimated. National health consequences are estimated for each of three future years (1980, 1990, and 2000) and for the periods 1980 to 1990 and 1980 to 2000. Projections in health effects are projected under all three scenarios. An effective long-term goal for automobile noise as measured at 50 feet, without regard to the economic feasibility, is in the range of 71-75 dBA for passby urban acceleration noise. Additional noise can be realized if noise emissions are reduced such as by 50% at 50 mph road load and lower speeds, automobiles emit noise as observed at 50 feet.

Task Force on Motor Vehicle Goals Beyond 1980, Marketing and Mobility

the Energy Res. and Devel. Administration, Federal Protection Agency, Dept. of Transportation, Regulatory Administration, and National Science

Office of the Secretary of Transportation, Section, TAD-443.1, Washington, D.C. 20590

## S OF THE FUTURE EFFECTS OF THE FUEL SHORTAGE AND INCREASED SMALL CAR

## USAGE UPON TRAFFIC DEATHS AND INJURIES. EXECUTIVE SUMMARY. FINAL REPORT

by Hans C. Joksche  
Center for the Environment and Man, Inc., 275 Windsor St., Hartford, Conn. 06120  
Contract DOT-TSC-839  
Rept. No. DOT-TSC-OST-75-21A ; 1976 ; 25p 3refs  
Report for Jun 1974-Dec 1975. For abstract, see HS-018 683  
Availability: NTIS

HS-018 683

## ANALYSIS OF THE FUTURE EFFECTS OF THE FUEL SHORTAGE AND INCREASED SMALL CAR USAGE UPON TRAFFIC DEATHS AND INJURIES. FINAL REPORT

The relationship between automobile size and the frequency of occupant death and injury was examined through a review of the literature and analysis of accident data. Four scenarios for the future development of the automobile market by size class were used to calculate consequences in terms of occupant deaths. It is estimated that a return to the 1972 market shares of subcompact and standard cars by 1985, but combined with a 50% increase in the market share of large luxury cars and a corresponding reduction in compacts and intermediates, would result in a 10% reduction in the average fatality risk for occupants of all cars, compared to 1972. An alternative ("D") including a doubling of the market share of compacts and subcompacts, a small increase for intermediates, and a reduction for standard and luxury cars together to 10% of the market is predicted to result in a 15% increase in the average fatality risk by 1985. Although various potential improvements of automobile design and construction which would reduce occupant injury and fatality risk are known, only the effects of the air cushion restraint system can be quantified at this time. If air bags were installed in cars beginning with the 1978 model year, the average fatality risk for all car occupants in 1985 would be reduced by about 30% under three of the market scenarios, and by about 15% under alternative "D." It was not possible to develop quantitative estimates of the effect of changes in travel volume or travel patterns due to the lack of basic information on the relations between exposure by quantity or quality and accidents. No precise estimate of the effect of the 55 mph speed limit could be made, because actual travel speeds are known for only very special traffic conditions. It is estimated that the lowered speed limit, as enforced, could be reducing the fatality risk for all car occupants in crashes by about 10%, by as much as 18%, or as little as 3%. If strictly enforced, the 55 mph speed limit could reduce the fatality risk by about 15%, possibly as much as 20%.

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Center for the Environment and Man, Inc., 275 Windsor St., Hartford, Conn. 06120  
Contract DOT-TSC-839  
Rept. No. DOT-TSC-OST-75-21 ; 1976 ; 186p 34refs  
Report for Jun 1974-Dec 1975.  
Availability: NTIS

HS-018 684

## **PUBLIC INFORMATION AND EDUCATION TELEPHONE SURVEY [DRUNK DRIVING COUNTERMEASURES]**

The Los Angeles Alcohol Safety Action Project is developing a multimedia advertising campaign regarding the problem of drinking and driving. The campaign is directed at people who associate with the drinker-driver either socially or professionally. The primary objective is to educate the group as to how they may intervene in drinking-driving situations. Throughout the campaign development, field research was utilized, both to evaluate the ultimate impact of the advertising and as a resource in developing specific commercials. The results and procedures of a pre-advertised survey of the population conducted through telephone surveys are described. The survey was conducted to determine what intervention actions Los Angeles residents could most easily be persuaded to attempt. The actions proposed were: limiting a friend's drinking, serving food or coffee, and offering a friend a ride home or a place to stay. A total of 938 survey interviews were conducted. The findings of the survey were that: among all respondents, limiting drinks was an unpopular intervention method; respondents expressed very favorable attitudes towards serving food or coffee, and providing transportation or a place to stay; youths are less inclined to serve food and coffee than are single and married adults; married adults and youths are generally more favorable toward intervention than are single adults; and women are more favorable toward intervention than men. Based on these findings, a list of recommendations for the content of the campaign's television commercials were formulated. Subsequently, the commercials are being designed to incorporate these recommendations. Among other things, the commercials will not promote the idea of limiting drinks; youths will not be asked to serve food or coffee; and a woman will be shown intervening in a drinking-driving situation.

by Julie A. Croke; Emanda B. Miller  
Los Angeles County Alcohol Safety Action Proj.  
1974 ; 56p 3reft  
See also HS-801 881.  
Availability: Reference copy only

HS-018 685

## **HIGHWAY ACCIDENT REPORT. MULTIPLE- VEHICLE COLLISIONS IN FOG, NEAR CORONA, CALIFORNIA, FEBRUARY 28, 1975**

On February 28, 1975, at 7:40 a.m., the first of a series of multiple-vehicle collisions occurred on State Route 91 near Corona, California. The collisions occurred in dense fog, with visibility between 35 and 50 feet. Personnel from the California Highway Patrol had begun escorting various vehicles through the fog in convoys when the collisions occurred. The first collisions occurred in the westbound lanes of Highway 91. About 10 minutes later, collisions occurred in the eastbound lanes. The total number of vehicles involved in the collisions were 60 automobiles and 24 commercial trucks. Many vehicles were destroyed, the rest damaged. A fire erupted when a truck struck an automobile. There were no fatalities resulting from the collisions, however, 23 persons were injured, 6 of whom were hospitalized. Estimated speed of the convoys at the time of the accidents was 20 mph. The National Transportation Safety Board determined that the probable cause of the collisions

was the penetration of vehicles into fog at speeds which were too high for the visibility conditions. The drivers had no advance information to warn them of the fog's severity and a reduced speed limit had not been posted. Further investigation revealed that many drivers did not know what they should do to avoid becoming involved in a collision in the fog. In view of this, it is suggested that the National Highway Safety Administration: assume a leadership role with driver educators to resolve the conflicting information being taught relative to driving tactics in fog; modify the Driver Education Standard to include more definitive information relative to reduced-visibility driving; and recommend to driver education instructors the need to stress in teaching of drivers that there is no single solution to the highway fog problem and point out the need to avoid or discontinue highway use until conditions allow safe travel. A map of the accident sites and photographs of several of the accidents are provided.

National Transportation Safety Board, Bureau of Surface  
Transportation Safety, Washington, D.C.  
Rept. No. NTSB-HAR-75-7 ; 1975 ; 30p refs  
Availability: NTIS

HS-018 686

## **RAILROAD/HIGHWAY ACCIDENT REPORT. SOUTHERN PACIFIC TRANSPORTATION COMPANY FREIGHT TRAIN/AUTOMOBILE GRADE CROSSING COLLISION, TRACY, CALIFORNIA, MARCH 9, 1975**

About 1:45 a.m. on March 9, 1975, three teenagers were killed when their automobile, moving at a speed of more than 50 mph, struck the side of the leading car of a slow-moving freight train at a crossing irregularly used by trains. The presence of the crossing was indicated by warning signs 500 feet and 380 feet in advance of the crossing and by crossbucks at the crossing. A train flagman at the crossing was unsuccessful in his attempts to stop the automobile. The driver's blood alcohol level (BAC) was 0.14% and the passengers' BAC levels were 0.10 and 0.09%. According to California State criteria and Federal criteria, a person with a BAC of 0.10% is presumed to be under the influence of alcohol. The National Transportation Safety Board determined that the probable cause of the accident was the failure of the automobile driver to make a proper approach to a known, identified crossing, and his failure to respond to the flagman's signals or to observe the train at, or on, the crossing until it was too late to avoid impact. The driver's failure to respond probably was caused by the influence of alcohol. The driver's previous driving record included three accidents in the year prior to the accident, and one driving conviction for speeding. A drawing of the accident scene and a photograph of the automobile are provided.

National Transportation Safety Board, Bureau of Surface  
Transportation Safety, Washington, D.C. 20594  
Rept. No. NTSB-RHR-76-1 ; 1976 ; 30p refs  
Availability: NTIS

HS-018 687

# **ACQUISITION, CALIBRATION AND APPLICATION OF A PAVEMENT SKID RESISTANCE TESTER. PHASE 1. SPECIFICATIONS AND ACQUISITION**

An evaluation of existing skid testing devices was made from available literature. Also a comparison of two-wheeled trailer units was made which includes correlation test results given in the literature. A cost-benefit analysis is provided. Results of a survey of users of two-wheel test units were used to develop specifications for the complete skid testing unit, as determined from all available data, which were used for acquisition of the tow vehicle and trailer, are included in totality. An addendum covering acquisition, costs, and some of the problems encountered is also included.

by B. G. Kessinger; J. E. Johnson  
Arkansas State Hwy. Dept., Div. of Planning and Res.  
Rept. No. HRC-29; PB-206 496 ; 1971 ; 38p 19refs  
Prepared in cooperation with the Federal Hwy.  
Administration.  
Availability: NTIS

HS-018 688

# **MOTOR VEHICLE REPAIRS AND INSPECTION PERSONNEL--MANPOWER DEVELOPMENT PROGRAM. FINAL REPORT**

In order to determine whether current automotive mechanic training programs provide adequate exposure to the knowledge and skills needed to properly service and repair motor vehicles, data were collected on the tasks, service and repair establishments, job market, labor force, and training programs in this field. Primary sources of information were reports prepared by various departments and offices of the government, supplemented by a review of the literature and interviews with persons knowledgeable about service and repair of automobiles and training of auto mechanics. Analysis of the information thus obtained indicates that: two-thirds of the auto mechanics are employed by dealership garages, independent garages, and gasoline service stations; out-of-school youth constitute the primary source of entry-level automobile service and repair personnel; public high schools perform most of the automotive mechanic pre-employment vocational training; the standard course guides developed by the Automobile Manufacturers Association and the United States Office of Education have national applicability and are current, complete, and satisfactory; course guides should be up-dated periodically; a shortage of highly skilled, experienced mechanics exist, while the demand for inexperienced graduates of high school automotive mechanic vocational training programs is relatively light; more mechanics are trained annually than are absorbed by the industry; and the present system of selection for participation in a high school pre-employment vocational training program is inappropriate and inefficient.

by R. W. McCutcheon; H. Schick; R. G. Mortimer  
University of Michigan, Hwy. Safety Res. Inst., Huron Pkwy.  
and Baxter Rd., Ann Arbor, Mich. 48105  
Contract FH-11-6963  
Rept. No. HSRI-HUF-7 ; 1970 ; 250p 94refs  
Availability: NTIS

HS-018 689

# **WHY YOUR BEST LIFE INSURANCE IS A PASSIVE RESTRAINT**

Research conducted by Allstate Insurance Company indicates that the most feasible means of preventing automobile injuries during crash events while simultaneously reducing insurance coverage rates is through the use of passive restraint systems. It is becoming apparent that such active restraint systems as the adjustable head restraint, ignition-interlock, and lap/shoulder belt systems are unacceptable to the public, as shown by their usage figures. The one quality that all the better designs have is that they require no action on the part of the occupant to perform their safety function in the event of a crash. The most viable passive restraint currently available is the air bag. This restraint offers convenience and reliability characteristics which will appeal to the general public. Cost benefit analyses have consistently favored the air bag over the other systems. Photographs of various collision-damaged vehicles and descriptions of restraint usage and resultant injuries are provided.

by Jack E. Martens  
Allstate Insurance Co.  
Rept. No. SAE-750390 ; 1975 ; 14p  
Presented at the Automotive Engineering Congress, Detroit,  
Mich., 24-28 Feb 1975.  
Availability: SAE

HS-018 690

# **HIGH CHEMICAL ACTIVITY OF INCOMPLETE COMBUSTION PRODUCTS AND A METHOD OF PRECHAMBER TORCH IGNITION FOR AVALANCHE ACTIVATION OF COMBUSTION IN INTERNAL COMBUSTION ENGINES**

Various concentrations of components of intermediate chemical reactions are formed in the flame front of a hydrocarbon-air mixture. Studies in cyclic and stationary flames of the kinetic formation, heat, and temperature of catalytic recombination of these components established the unusually high concentration of ionized atoms and radicals in the branching chain reactions which can exceed the thermodynamic equilibrium by an order of two to four. These are formed in the flame of a rich mixture possessing a 30 to 60% insufficiency of air, and concentrations of these reactive elements sharply diminish as the rich mixture is leaned toward stoichiometric. An analysis of the hydrodynamical structure in the combustion zone, initiated by the burned products of combustion fed from an auxiliary combustion chamber, led to the discovery of a means to develop turbulent vortex kernels in the wake of the prechamber torch to achieve rapid and efficient combustion. Optimization is achieved by employing a prechamber volume of 2 to 3% of the compressed combustion chamber volume, using connecting channels of specific area and length to diameter ratio. This research work has led to the development of the "LAG-Process" of combustion, which utilizes the high chemical activity of the products of incomplete combustion of a rich auxiliary mixture to produce fast, complete, and stable combustion in the working main mixture within the combustion chamber of various types of engines. The delay period of ignition of the main mixture is decreased by 5 to 7 times and the combustion duration is significantly decreased by 3 to 4 times in comparison to spark ignition. A 10% improvement

in combustion efficiency is achieved and the overall combustion becomes exceptionally stable and reproducible.

by L. A. Gussak  
Institute of Chemical Physics, Academy of Sciences of the USSR, Moscow  
1975 ; 27p 22refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 691

## COMPARISON OF OIL ECONOMY IN LARGE AND SMALL PASSENGER CAR ENGINES

A study was conducted to compare the oil consumption characteristics of large and small automobile engines. A fleet of 120 employee-owned vehicles was operated in typical passenger car service in the Cleveland, Ohio, area between April and December, 1974. The fleet consisted of 50 small cars and 70 large cars selected more or less random from a total of about 1,000 employee-owned vehicles. Oil consumption was determined by a 'drain and weigh' technique. Two test oils of equal viscosity but widely varying volatility characteristics were used for the study. The results showed no correlation between engine size and oil consumption. The results also showed no difference in oil consumption between the test oils. The results did show the expected trend toward higher oil consumption with increasing engine mileage. The development of a standardized laboratory procedure which correlates with oil consumption in passenger cars is recommended. It is concluded that a shift to smaller cars will not cause a major change in the total demand for gasoline engine oils.

by Robert J. Main; Robert W. Scher  
Lubrizol Corp., Mechanical Testing Lab.  
Rept. No. SAE-750899 ; 1975 ; 10p 16refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 692

## DEPOSITS, WEAR, AND CATALYST PERFORMANCE WITH LOW ASH AND ASHLESS ENGINE OILS

To meet exhaust emission standards, nearly all 1975 model U.S. passenger automobiles use catalytic converters in conjunction with unleaded gasoline. While it has been established that lead and phosphorus from gasoline are deleterious to catalyst performance, much less is known about any similar effect of elements normally present in conventional engine oils. In addition, the ability to protect engines from excessive deposits and wear is essentially unproven for engine oils in which the phosphorous and metals contents have been either reduced (low ash oils) or eliminated (ashless oils). To obtain catalyst and engine performance information on such oils, tests were run using 95, 1972-1973 model passenger cars, operated with unleaded gasoline in several types of service. Forty cars were equipped with 1975 production-prototype General Motors underfloor catalytic converters containing pelleted oxidation catalysts. Neither exhaust emissions nor catalyst conversion efficiency were affected by using either a low ash or ashless oil instead of a conventional oil. However, oil consumption was less than typical for such service,

so the effect of oil additives on catalyst durability may be seen proportionately less. Five experimental ashless oils all deficient in engine performance to varying degrees compared to conventional commercial quality oils, with respect to cam and litter wear, oil ring sticking, and piston deposits. It is concluded that reduction in phosphorous metals content of current, conventional, commercial oils does not appear to be necessary to meet current exhaust emission standards with current General Motors catalyst systems. However, development of ashless oil technology should continue as the event such oils are necessary to meet future more stringent engine or emission requirements.

by Loren G. Pless  
General Motors Corp., Res. Labs.  
1975 ; 17p 16refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 693

## EXHAUST EMISSIONS FROM HEAVY-DUTY TRUCKS TESTED ON A ROAD COURSE AND BY CHASSIS DYNAMOMETER

A summary compilation and limited comparison/analysis of results from a group of ten pre-emission-controlled, post-1970 (emission controlled) gasoline-powered trucks and diesel-powered trucks is presented. The trucks were tested over a driving course known as the San Antonio Route (SARR), and by chassis dynamometer versus Federal exhaust emission test procedures. Methods of comparison included grams per minute, grams per pound of fuel, grams per mile, and fuel economy in miles per gallon and miles per gallon. Exhaust emissions measured on the road showed that the diesels emitted less than the conventional gasoline vehicles, which in turn emitted less than the pre-controlled gasolines for both hydrocarbons and carbon monoxide. For nitrous oxides, the results were just the opposite. In terms of grams per ton-mile, the comparative levels of emissions were of the same order as those expressed in terms of grams per pound of fuel, with the exception of nitric oxides. The controlled gasoline vehicles emitting the least were followed by the pre-controlled gasolines, and then by the diesels. With regard to the ratios of chassis-dynamometer emissions to road-route emissions, this ratio was less than one for hydrocarbons and carbon monoxides for all vehicles tested, greater than one with regard to nitric oxides. The operational performance data indicate that there was little difference in the way the diesel and gasoline-powered vehicles operated over the SARR. The average fuel economy for the diesel-powered vehicles in ton-miles per gallon, however, was about two times the fuel economy of the gasoline-powered vehicles. The compilation represents 400 SARR runs and chassis dynamometer tests.

by Gordon J. Kennedy; John T. White, 3rd; Karl J. Spring  
Melvin N. Ingalls  
Environmental Protection Agency; Southwest Res. Inst.  
Contract EPA-68-03-2113 ; EHS-70-113 (Part 1); EPA-68-03-0441  
Rept. No. SAE-750901 ; 1975 ; 21p 6refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

## APPLICATION OF HEAVY-DUTY CATALYTIC CONVERTERS ON MEDIUM AND HEAVY-DUTY GASOLINE POWERED TRUCKS

The use of an oxidation type catalytic converter for medium and heavy-duty gasoline powered trucks is discussed. The converter offers the highest reductions of hydrocarbons and carbon monoxide, while being simple, durable and cost effective in reducing pollution from trucks without fuel or driveability penalties. Emission reductions resulting from the retrofit installation of catalytic converters on trucks has been excellent. The emission control deterioration indicated in a comparison of reduction before and after running for 300 hours shows a similarity to light-duty trucks with equivalent operating times. Three sizes of pelleted type heavy-duty catalytic converters were produced for the truck installations, and evaluated on a diverse fleet of 14 trucks ranging from 7,500 to 44,000 lbs gross vehicle weight. Excessively rich air/fuel mixtures for prolonged periods of operation resulted in thermal destruction of converters more frequently than could be tolerated. A converter over-temperature protection system was installed on three trucks, and data gathered indicated that thermal destruction could be eliminated. From six to twelve hours of labor were required for a complete converter installation that included the catalytic converter, an air pump and hoses, valves, and accessories.

by T. V. De Palma; C. H. Bailey  
Universal Oil Products Co., Automotive Products Div.  
Rept. No. SAE-750902; 1975; 9p Srefs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 695

## EMISSIONS CONTROL OF GASOLINE ENGINES FOR HEAVY-DUTY VEHICLES

An investigation of reductions in exhaust emission levels attainable using various techniques appropriate to gasoline engines in vehicles over 14,000 lbs gross vehicle weight is summarized. Of the eight gasoline engines investigated, two were evaluated parametrically resulting in an oxidation and reduction catalyst "best combination" configuration. Four of the engines were evaluated in an Exhaust Gas Recirculation (EGR) plus oxidation catalyst configuration, and two involved only baseline tests. Test procedures used in evaluating the six "best combination" configurations included: three emission test procedures using an engine dynamometer; a determination of vehicle driveability; and two vehicle emission test procedures using a chassis dynamometer. Dramatic reductions in emissions were attained with the catalyst "best combination" configurations. Engine durability, however, was not investigated. Appendices include: emission test procedures for heavy-duty vehicle engines; test engine descriptions; and a comparison of stationary dynamometer procedure results and baseline engine emissions.

by Charles M. Urban; Karl J. Springer; John J. McFadden  
Southwest Res. Inst.; Environmental Protection Agency  
Contract EPA-68-01-0472  
Rept. No. SAE-750903; 1975; 14p 10refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975. Final report for the work done under this contract is available from the EPA Air Pollution Technical Information Center as EPA-460/3-74-007(1).  
Availability: SAE

## THE USE OF CONSTANT VOLUME SAMPLER AND DILUTION TUNNEL TO COMPARE THE TOTAL PARTICULATES FROM A RANGE OF AUTOMOTIVE ENGINES

The development of a simple constant volume sampler (CVS) particulate test and its application to various engine types is shown to quantify a number of problem areas. Research into the reduction of particulates in exhaust gases can be carried out more effectively by this technique than by the older optical methods. The results quantify subjective estimations to the extent of the particulate problem and identify the areas needing the greatest attention. Public concern over the emissions from 2-stroke motor cycles, diesel vehicles and worn gasoline vehicles is shown to be justified. Total particulates from many vehicles are running at levels at or above the hydrocarbon standard of 0.41 grams per mile which, in view of their offensive nature, may point to an anomaly in the emissions situation. It is premature, however, to condemn engine types on the basis of the scant attention given so far to this problem. A new branch of emissions technology is needed urgently, together with guidance on the definition and description of particulates which must come from official bodies and ambient air quality specialists. Diagrams of the CVS and its components are included.

by D. Collins; R. D. Cuthbertson; R. W. Gawen; R. W. Wheeler  
Ricardo Consulting Engineers  
Rept. No. SAE-750904; 1975; 16p 9refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 697

## CONTROL OF REFUELING EMISSIONS WITH AN ACTIVATED CARBON CANISTER ON THE VEHICLE

The investigation of the technical and economic feasibility of using a carbon canister on board a vehicle to retain displaced hydrocarbon vapors during refueling is documented. To initiate the design of a prototype carbon canister system capable of handling refueling vapor losses, studies were undertaken on a bench test system capable of handling refueling vapor losses, studies were undertaken on a bench test system to define the total amount of refueling vapor to be handled, vapor retention capacity of activated carbon, and purge capacity over a range of refueling conditions and fuel system parameters. In addition, extensive exhaust and evaporative emission tests were performed on the baseline vehicle and the modified vehicle. Detailed cost and effectiveness analyses were performed. It is concluded that: a canister containing 2,000 grams of activated carbon effectively controlled refueling vapor losses and evaporative emissions; refueling vapor losses during severe conditions were determined to be 5.4 grams per gallon of fuel refilled on the average; the cost to the consumer for the addition of the refueling control capability is estimated to be \$4.85 per vehicle and the fuel savings over a 10-year period would approximate the cost of the system; driveability testing with the prototype system did not indicate impairment; evaporative emission testing revealed no adverse effects; exhaust emission testing with the prototype system showed that the carbon monoxide level increased, oxides of nitrogen decreased, and the hydrocarbons level was not significantly affected; and ad-

ditional developmental work is necessary to minimize the effects on exhaust emissions and to integrate the evaporative and refueling emission control systems.

by J. A. Gunderson; D. K. Lawrence  
Olson Labs., Inc.; Amoco Oil Co.  
Rept. No. SAE-750905 ; 1975 ; 24p 6refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 698

### STX [TRADE MARK] SHEETS--A FAMILY OF GLASS REINFORCED ENGINEERING POLYMER MATERIALS

The stampable sheets of a family of glass reinforced engineering polymer sheet materials (STX), the part conversion processes, and some potential uses of these converted plastics in the automotive industry are discussed and reviewed. Photographs of STX components and die construction diagrams are provided. STX structural nylon-6 sheets contribute another dimension to structural high temperature applications now available to parts designers, and STX surface grade sheets add a further degree of freedom in surface applications.

by L. A. Dunning  
Allied Chemical Corp., Fibers Div.  
Rept. No. SAE-750911 ; 1975 ; 10p 7refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 699

### CHEVROLET MONZA FRONT END RETAINER: A CASE STUDY OF AZDEL APPLICATIONS

Aspects of thermoplastic stamping as a viable economic process in the manufacture of automotive components, particularly the Chevrolet Monza front end retainer, are discussed. This component represents a significant commercial reality for thermoplastic stamping in a high volume, structural application.

by R. D. Margolis  
G. R. T. L. Co.  
Rept. No. SAE-750912 ; 1975 ; 5p  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 700

### AN EVALUATION OF MANGANESE AS AN ANTIKNOCK IN UNLEADED GASOLINE

Methylcyclopentadienyl manganese tricarbonyl (MMT) is an antiknock additive for unleaded gasoline. Use of MMT in gasoline at a concentration of 0.125 gram of contained manganese (Mn) per gallon provides, on the average, about two road octane numbers. Compared to processing, this could represent a savings in crude oil of about 1%. Like other antik-

tration range is compatible with general aspects of car operation (octane number requirement, exhaust valve and spark plug durability, and exhaust gas recycle for nitrogen oxide control). Beneficial effects in exhaust valve guide and seat wear have been observed with MMT in some tests. In tests using cars operated on the 50,000 mile Environmental Protection Agency certification schedule, the use of MMT had no significant adverse effect on emissions as compared to unleaded gasoline. Other tests have shown a decrease in exhausted polynuclear aromatics through the use of MMT. MMT does not lessen the effectiveness of exhaust catalysts in oxidizing unburned hydrocarbons and carbon monoxide. It is estimated that the median airborne Mn concentration in urban areas from widespread use of MMT would be 0.05 microgram per cubic meter; in freeway situations, estimated concentrations would be generally less than one microgram per cubic meter, rising above this level only under the most unfavorable meteorological conditions.

by J. E. Faggan; J. D. Baile; E. A. Desmond; D. L. Lenane  
Ethyl Corp.  
Rept. No. SAE-750925 ; 1975 ; 46p 21refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 701

### THE ENVIRONMENTAL IMPLICATIONS OF MANGANESE AS AN ALTERNATE ANTIKNOCK

New information related to the effect of manganese gasoline additives on the performance of catalysts, regulated emissions, and several currently unregulated emissions (total particulate and exhaust aldehydes) is reviewed and discussed. In addition, estimates of human exposures to automotive-generated manganese particulate and the toxicological characteristics of manganese are discussed as they related to an assessment of the potential public health consequences should manganese additives come into widespread use. The Environmental Protection Agency's position regarding the use of manganese additives is presented. It is concluded that: the use of manganese in gasoline results in increased total particulate emission rates and increased aldehyde emissions; manganese in gasoline tends to result in reduced particulate carbon emissions and increased emissions of hydrocarbons; manganese has a detrimental effect on atmospheric visibility at exhaust-air dilution ratios of 1:3000 after 23 hours of irradiation; and while not posing a direct disbenefit to public health in itself, manganese results in detrimental effects on some regulated and non-regulated emission products while evidencing no clear public health benefits.

by John B. Moran  
Environmental Protection Agency  
Rept. No. SAE-750926 ; 1975 ; 57p 18refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 702

# **TOXICOLOGIC EVALUATIONS OF FUEL ADDITIVE--METHYLCYCLOPENTADIENYL MANGANESE TRICARBONYL (MMT)**

Data are presented from experiments with laboratory animals on the toxicity and metabolic fate of the fuel additive methylcyclopentadienyl manganese tricarbonyl (MMT) and the biological effects following exposure to automotive exhaust emissions generated from an engine system which was run on a fuel containing MMT. Rats and hamsters were used in the research and a 1972 Chevrolet 350 cubic inch engine-dynamometer system was used for generation of the exhaust gases. It is indicated that MMT is highly toxic by all routes of exposure studied. Human symptoms associated with skin and respiratory exposure to MMT have been found to include: metallic taste, headache, nausea, dyspnea, tightness of the chest, paresthesias, and elevated levels of urinary manganese (Mn). The most important factor that should be considered in determining the environmental impact of MMT is whether its usage will cause a significant increase in the ambient levels of Mn in highly populated areas with high traffic density. Further studies are needed to determine the lowest atmospheric Mn concentrations which will produce clinical Mn-intoxication and the possible chronic effects of long term exposure to automotive exhausts containing Mn. MMT is considered a substitute for tetraethyl lead as an octane improving fuel additive.

by W. Moore; J. F. Stara; D. Hysell; M. Malanchuk; J. Burkart; R. Hinners  
Environmental Protection Agency, National Environmental Res. Center  
Rept. No. SAE-750927 ; 1975 ; 10p 9refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 703

# **AN EVALUATION OF ALTERNATIVE POWER SOURCES FOR LOW-EMISSION AUTOMOBILES**

Two successive surveys and round-robin interviews were conducted to determine the state of development of an alternative automobile engine exhibiting low emissions meeting the most stringent standards. Comparison of engines was handled in terms of selected acceptability factors which went well beyond emissions alone. The overall acceptability was evaluated in terms of emissions, customer requirements for an engine, and engine efficiency and fuel versatility. An attempt was made to establish a time scale regarding research and development requirements and eventual production. Comparison of all engines (spark ignition gasoline, gas turbine, steam, Stirling, and electric engines) was made with equivalent pre-control Otto cycle engines as the standard. Evaluations of the engine characteristics, comparison with pre-control spark ignition engines, problems yet to be solved, and the most optimistic time schedule to be anticipated are attempted and reported. Best candidate power plants are then enumerated. Keeping in mind that the future will require lowered emissions in urban air and improved efficiency of the overall transportation system, comment is made on the use of engines and automobiles. Methods of accomplishing, in part, the goals of the clean air act with changes in the structure of the transportation system, taxes,

that low-emission engines are only one part of the overall problem of maintaining clean air and viable urban centers.

by John W. Bjerklie; Elton J. Cairns; Charles W. Tobias; David Gordon Wilson  
Hague International; Argonne National Lab.; University of California at Berkeley; Massachusetts Inst. of Tech.  
Rept. No. SAE-750929 ; 1975 ; 19p 67refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 704

# **LEAN BURN ENGINE CONCEPTS--EMISSIONS AND ECONOMY**

Lean burn engine concepts for meeting emission standards features versus the use of an oxidizing catalytic converter for hydrocarbon and carbon monoxide control are discussed. Purely theoretical considerations indicate that thermal efficiency and therefore fuel economy should be improved by lean operation.

by James E. A. John  
University of Toledo, Mechanical Engineering Dept.  
Rept. No. SAE-750930 ; 1975 ; 11p 15refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 705

# **THE DIESEL AS AN ALTERNATIVE AUTOMOBILE ENGINE**

An evaluation is made of the use of the diesel as an alternative engine in passenger cars, including the technological feasibility for meeting the different emission standards and the techniques for emission control. The emissions studied include both the presently regulated species, hydrocarbons, carbon monoxide and nitrogen oxides, and the following non-regulated emissions: aldehydes, ammonia, smoke and particulates, polynuclear aromatics, and sulfur compounds. A comparison is made between the emissions, performance and economy of currently produced diesel powered cars and gasoline powered cars. Other cars which are being developed and powered by the stratified charge, Wankel, and the gas turbine engines are also included in the comparison. Intrinsic problem areas in the diesel engine that need further research are also identified and discussed.

by Naeim A. Henein  
Wayne State Univ.  
Rept. No. SAE-750931 ; 1975 ; 17p 44refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 706

# **SOME OBSERVATIONS OF FACTORS AFFECTING ORI (OCTANE REQUIREMENT INCREASE)**

A review is presented of anomalies that exist in the changes in

conducted to elucidate possible reasons for some of these anomalies. These tests have uncovered mechanical variables that can produce relatively rapid changes in the octane requirement of an engine and octane requirement differences between engines of the same make and model, operated on identical combinations of gasoline and oil. Two of the more important variables are the initial octane requirement and the amount of oil migrating to individual cylinders in the engine.

by H. E. Alquist; G. E. Holman; D. B. Wimmer  
Phillips Petroleum Co., Res. and Devel. Div.  
Rept. No. SAE-750932; 1975; 21p 19refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 707

### **SOME FACTORS WHICH AFFECT OCTANE REQUIREMENT INCREASE**

The influence of selected engine oil, fuel, and driving schedule variables on combustion chamber deposits and octane requirement increase (ORI) has been investigated during vehicle fleet tests with 125 late model cars. Greater ORI's occurred with an engine oil containing bright stock compared to an engine oil without bright stock; an unleaded fuel containing a polymeric detergent-dispersant additive with a large amount of carrier oil, compared to other unleaded fuels with conventional additive packages; and customer-type driving compared to rapid mileage accumulation on a chassis dynamometer. ORI was not affected by: lead content of the fuel; or ashless engine oil compared to a conventional ash-containing oil. All of the ORI with unleaded fuel can be eliminated by removing the combustion chamber deposits, and about two-thirds of the ORI is caused by deposit accumulation in the end-gas region of the chamber. In late model cars using unleaded fuel, about 10% of the ORI is due to the volume effect of deposits and the other 90% is probably due to thermal effects.

by Jack D. Benson  
General Motors Res. Labs., Fuels and Lubricants Dept.  
Rept. No. SAE-750933; 1975; 21p 15refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 708

### **OCTANE NUMBER REQUIREMENT TRENDS--PASSENGER CARS IN U.S., 1965-1974**

A review, based on nationwide surveys of octane number requirements (ONR) for current model passenger cars from 1965 through 1974, in which trends in ONR's reflect changes in engine design and exhaust systems to meet the legislated limits on emissions, is presented. The average ONR dropped approximately 5.5 research octane numbers over the ten-year period with most dramatic drop of about 3.0 octane numbers in 1971 when car manufacturers recommended use of 91 octane gasoline. The trends toward lower average requirements since 1971 have been determined with both leaded and unleaded fuels. Incidence of surface ignition knock and rumble was about one percent in 1965 and tended to disappear after

1971. The average spread of ONR's between 10 and 90% of cars satisfied increased about 2.5 numbers over the period.

by D. P. Barnard; J. D. Rogers, Jr.; W. L. Wascher  
Standard OilCo. (Ohio); E. I. du pont de Nemours, and Co.,  
Inc., Mobil Res. and Devel. Corp.  
Rept. No. SAE-750934; 1975; 41p 16refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 709

### **THE RELATIONSHIP BETWEEN OCTANE QUALITY AND OCTANE REQUIREMENT**

The use of road octane number equations to predict the antiknock performance of motor gasoline under a wide variety of operating conditions is described. The method by which the reference fuels are used to determine the octane requirement of engines in terms of octane numbers and front-end quality and the information used to calculate what proportion of any given market will be satisfied by gasolines of known inspection properties is also discussed. Brief mention is made of the relationship between the calculated values of car satisfaction and observed levels of customer satisfaction and the effects of lead, aromatics and olefins on road antiknock performance. Future octane quality is discussed and the need for close cooperation between the oil industry, the automobile industry and legislators is identified. Relevant illustrative graphs are provided.

by A. G. Bell  
Shell Res. Ltd., Thornton Res. Centre (United Kingdom)  
Rept. No. SAE-750935; 1975; 18p 9refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 710

### **ADVANTAGES OF LEAD IN GASOLINES FOR EUROPEAN CARS--THE LEAD ROAD BONUS**

The term "lead road bonus" (all of the road performance advantages of lead alkyl antiknocks beyond their effects in increasing octane numbers) is fully defined and variations in the results reported to date on lead road bonus studies in Europe are explained. Results from several road test programs involving direct measurements of the effects of lead concentration and lead alkyl type in gasolines for European cars are presented. Tests of 81 different fuels are reported. It is concluded that: the use of lead antiknocks in European gasolines usually provides a positive lead road bonus; the magnitude of the lead bonus varies with the composition of the base gasolines, the car considered, and the operating conditions imposed; in European cars and fuels, tetramethyllead shows larger road octane advantages than tetraethyllead for most road operating conditions; and lead advantages are greater when the operating conditions are severe. Complete test result data are appended.

by D. D. Hornbeck; R. M. Labruyere; L. E. Stinson; G. H. Unzelman  
Ethyl International  
Rept. No. SAE-750936; 1975; 24p 13refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE



October 31, 1976

HS-018 715

HS-018 711

### **OCTANE NUMBER INCREASE OF MILITARY VEHICLES OPERATING ON UNLEADED GASOLINE**

The suitability of using unleaded gasoline in military and commercially designed equipment located at four United States Army installations has been evaluated over a two-year period. A total of 3007 vehicles were monitored during the evaluation for maintenance and performance problems. Information on vehicle octane number requirements and octane number increase trends measured on a selected group of vehicles during the evaluation period is presented. Fifteen vehicles were evaluated at each of two sites selected for their opposite extremes in temperature, humidity, and altitude. The octane requirement increases at the two sites have been 2.7 and 2.1 numbers. The current program will allow the establishment of plateaus in octane number requirement increase in vehicles changing from leaded to unleaded gasolines and will also determine the effect of unleaded gasoline in 1975 vehicles. Details of the fuels used, vehicles tested, test procedure and results are discussed.

by J. D. Tosh; J. T. Gray; E. B. Trescott  
Southwest Res. Inst., Army Fuels and Lubricants Res. Lab.;  
Army Material Command  
1975; 11p 7refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 712

### **THE USE OF COMBUSTION DEPOSIT ANALYSIS FOR STUDYING LUBRICANT-INDUCED ORI [OCTANE REQUIREMENT INCREASE]**

A progress report of a continuing program aimed at understanding the role of the engine oil viscosity index improver (VII) in octane requirement increase (ORI) is presented. Two polymers, one hydrocarbon and one ester, have been examined in a closely controlled ORI experiment. A variety of measures were employed to block out other variables. The two test oils were separately evaluated in two similar 1975 cars operating with commercial unleaded gasoline. A detailed analysis of the deposits resulting from 15,000 miles of dynamometer operation supplemented the conventional octane ratings. Conclusive differences were not found in terms of observed ORI or in the total volume of combustion chamber deposits. However, the olefin copolymer VII was directionally lower in ORI and seemed to have a qualitative advantage in engine deposit formation and location. Several of the experimental techniques used appear to have potential for future study.

by H. E. Bachman; E. B. Prestridge  
Exxon Chemical Co., Paramins Technology Div.; Exxon Res.  
and Engineering Co., Analytical and Information Div.  
Rept. No. SAE-750938; 1975; 13p 7refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

transportation in certain districts are emphasized. Data from 49 Texas school districts for the academic year 1972-1973 are tabulated. It is concluded that: the cost differential between rural and small town and urban transportation may not be as large as has been previously assumed; a model has been developed herein that predicts variability in transportation costs per pupil from independent variables that are not transportation system specific; and the model accounts for more than 50% of variability in transportation costs per student and an average of 80% of total operating costs per district.

by Ronald Briggs; David Venhuizen  
Publ: Traffic Quarterly v30 n2 p303-23 (Apr 1976)  
1976; 2refs

Partially supported by the Department of Transportation and the State of Texas, Governor's Office of Educational Res. and Planning through contracts with the Council for Advanced Transportation Studies, University of Texas at Austin.  
Availability: See publication

HS-018 714

### **BICYCLE SAFETY MANUAL. SAFE RIDER NOW. SAFE DRIVER LATER**

A manual, designed as a planning guide to help communities in establishing a comprehensive bicycle safety program, is presented. Fundamental procedures of an organized program for testing, registering and/or licensing of all bicycles and for improving the skill and practices of all riders are outlined. The procedures involve: testing all bike owners on their knowledge of traffic rules and regulations, as well as their riding ability; inspecting all bicycles for mechanical defects; and registering and/or licensing of all bicycles. The following information is given: relevant bicycle accident statistics for Indiana and the United States; Indiana bicycle laws; a safety inspection check list; a preliminary planning procedure; suggestions for a bicycle rodeo; suggestions for skill and information tests and their scoring; ideas for traffic instruction schools and a bicycle safety court; a discussion of the relationship of the car and the bicycle; and sources for bicycle safety films and literature.

Indiana Dept. of Traffic Safety and Vehicle Inspection,  
Graphic Arts Bldg., 215 N. Senate, Indianapolis, Ind. 46202  
n.d.; 30p  
Availability: Corporate author

HS-018 715

### **ROAD HAZARDS AND THE MOTORCYCLIST**

A summary of road hazards affecting motorcyclists is presented. The effects of the skidding resistance of road surface, other road surface factors such as drainage and repairs, traffic signals, street lighting, road signing, crash barriers and other roadside obstacles, traffic control factors, vehicle parking, and motorcycle construction and use on the degree of hazard are discussed. The more important aspects of British motorcycle legislation are briefly listed. It is concluded that: much greater attention should be paid to minimizing motorcycle road hazard; great hazard reduction would be achieved by the application of already established principles and enforce-

be prohibited on all streets not properly lighted. Recommendations are offered which should benefit all motorists.

British Motorcyclists Federation, Ltd., 225 Coventry Rd., Ilford, Essex, IG1 4RF, England  
1974; 12p 10cfs  
Memorandum submitted to the Minister for Transport, October 1974.  
Availability: Corporate author

HS-018 716

## **PROBLEM DRIVERS: THE EFFECTS AND AFTER EFFECTS OF ALCOHOL ON DRIVER PROFICIENCY**

With two extensive literature surveys as background an experimental study was conducted measuring the effects and after effects of alcohol on driving and on certain abilities related to driving. A driving simulator was used to measure the driving ability of 96 volunteer male drivers (average age 31.8 years). A total of 74 drivers were tested before and after 3.2 milliliters of alcohol and the other 22 served as the control group. Visual ability and attention were tested. It was found that: visual abilities (visual acuity, depth perception, and glare resistance) are significantly impaired when the blood alcohol level (BAC) reaches 0.08%; about 10 hours after a BAC of 0.12% had been reached and had returned to normal, visual ability was significantly impaired; in driving the simulator certain aspects of the driving task were significantly impaired at a BAC of 0.08% and the driving error most often made was driving too far to the left; the performance of an attention-dividing and a driving task together resulted in an increase of errors in all aspects of the driving task; the average variances in reaction time of the experimental group increased by about 300% when the BAC reached 0.08%; 10 hours after alcohol intake when the BAC had returned to normal, significant deterioration compared to before alcohol appeared in measures of simple reaction time, judgment of time and judgement of movement; and although certain abilities which are mainly biological were impaired in the older groups (32 years and older) after alcohol, these subjects revealed some control over their psychological processes which compensated for the biological impairment. Descriptions of the measuring instruments, copies of the biographical and accident history questionnaire used, and results of the blood alcohol analyses are appended.

by Monica D. Enslin; (M. D. van der Nest)  
National Inst. for Personnel Res., Council for Scientific and Industrial Res., Psychometrics Div., P.O. Box 10319, Johannesburg, Republic of South Africa  
Rept. No. CSIR-SR-PERS-222; 1975; 61p 44cfs  
Sponsored by the National Road Safety Council.  
Availability: I Corporate author

HS-018 717

## **A CONVERSATION WITH TEXANS ABOUT DRUGS AND DRUG ABUSE. REV. ED.**

An information guide to drugs and drug abuse has been prepared by the Texas Department of Community Affairs. General questions about the nature of drugs, drug addiction, and drug abuse are answered. The following specific categories of drugs which tend to be abused are discussed at length: marijuana; hallucinogens; narcotics; stimulants, including amphetamines, methamphetamines, and cocaine; downers, sedatives, barbiturates, and hypnotics; and sniffers and in-

halers. These drugs are described, the effects of the drugs are outlined, and problems related to abuse of the drugs are identified. Specific drugs within each category are identified. Texas laws with regard to drug abuse are reviewed. The Texas State Program on Drug Abuse (SPODA) is responsible for the preparation and administration of the State Plan for Drug Abuse Prevention and for obtaining Federal drug funds for the state. SPODA is also responsible for carrying out education programs designed to prevent or deter the misuse or abuse of controlled substances and to encourage research on these substances. A glossary of street talk terms related to drugs is included. A list of recommended publications and films on drugs and drug abuse is presented.

State Program on Drug Abuse, Texas Dept. of Community Affairs, P.O. Box 13166-Capitol Station, Austin, Tex. 78711  
1975; 66p 37cfs  
Availability: Corporate author

HS-018 718

## **NATIONAL FORUM ON TRAFFIC RECORDS SYSTEMS (1st) PROCEEDINGS, NEW ORLEANS, LOUISIANA, 12-14 NOV 1974**

The objective of the first National Forum on Traffic Records Systems was to bring together working professionals in the development and use of traffic records systems for the purpose of hearing presentations and exchanging information. Topics covered by the Forum included: the administration and management of traffic records systems; data analysis reports; uses and users of traffic records systems; intergovernmental and interstate data exchange; and special reports of the Traffic Records Committees and national organizations. The following areas of traffic records systems program administration and management were addressed: traffic records system transferability; accident information systems; the administration of state and local traffic records systems; and a description of a statewide and successful integrated traffic records system. Traffic records uses which were examined included: research uses and accident records; the Highway Loss Data Institute; the use of traffic records for annual work plans; and the use of a systems approach to traffic records. The use of data analysis in research, program evaluation in motor vehicle departments, identification of the causative factors of traffic accidents, and selective enforcement programs was examined. Intergovernmental and interstate data exchange programs which were discussed included: the National Driver Register; the National Crime Information Center; and the National Law Enforcement Telecommunications System.

National Safety Council, 425 N. Michigan Ave., Chicago, Ill. 60611  
1974; 174p  
Cover title: First National Forum on Traffic Records Systems, November 12-14, 1974. Sponsored and conducted by the National Safety Council in cooperation with the American Assoc. of Motor Vehicle Administrators, National Conference of Governors Hwy. Safety Representatives, and the Transportation Res. Board's Traffic Records Com.  
Availability: Corporate author

HS-018 719

## **A STUDY OF SPEED BUMPS**

The City of San Jose, California, has investigated the potential effectiveness of various types of speed bump configurations in

reducing vehicle speeds, with determination of potential liability difficulties being limited to immediate vehicle damage or driver loss of control. One of the primary methods used to evaluate the potential effect of speed bumps on reducing speeds was the rating of passenger discomfort and noticeability. This evaluation was based on the assumption that a well-designed speed bump should inflict increasing discomfort and noticeability in proportion to the amount that the vehicle exceeded the design speed of the bump. Based on the test data, the following conclusions were reached: the speed bumps tested were not effective in reducing vehicle speeds; speed bumps present an immediate and specific hazard to some vehicles, particularly bicycles, motorcycles, and fire trucks, and a potential hazard to all vehicles; it is probably impossible to design an effective narrow speed bump for all types of vehicles; and speed bumps would cause noise pollution in residential neighborhoods.

by Lawrence B. Walsh  
City of San Jose Dept. of Public Works, Transportation Div.,  
San Jose, Calif.  
1975 ; 84p 1ref  
Availability: Corporate author

HS-018 720

## **CHANGING DWI BEHAVIOR--STRATEGIES FOR THE DWI EDUCATOR**

A community action program developed by the American Automobile Association, called DWI Counterattack, supplements judicial and enforcement activities with education and rehabilitation efforts. The objective of the DWI Counterattack program is to change the behavior patterns of those who now drink and drive. In order to do this, persons apprehended for driving while under the influence (DWI) are provided with information on the cases and consequences of drinking and driving, suggestions are made with regard to personal countermeasures against future DWI behavior, DWI's are encouraged to analyze their drinking habits against the opinions of peers and teachers, and ways in which DWI behavior can be modified are examined. The teacher in a DWI school must be able to relate a knowledge of DWI's, including characteristics, attitudes, and classifications, to specific instructional strategies designed to change DWI behavior. A summary of the characteristics of the typical DWI, of the attitudes of DWI's toward their convictions, and of the various types of drinkers apprehended for DWI is presented. The premise that information about the consequences of drinking and driving will help a person better select alternatives to DWI behavior is central to the rationale of the DWI Counterattack program. This rationale seems to be substantiated by DWI students. The most effective individualized approach is probably the development of personal countermeasures against future DWI behavior. A countermeasure program must be individualized in order to be effective, since individuals must alter their behavior if drinking and driving problems are to be reduced.

by John D. DeLellis  
American Automobile Assoc.  
1974 ; 18p 3refs  
Presented at the DWI Instructors Workshop, San Francisco,  
28 Oct 1974. Based on Drunken Driving: the Twelve Hours  
Before Arrest and What to do About Them, a computer  
analysis of 2,653 Phoenix DWI case histories conducted by  
James Malfetti and Ernest Stewart.  
Availability: Reference copy only

HS-018 721

## **BLOOD ALCOHOL IN BREATH DETERMINED BY ASD AND IN BLOOD BY WIDMARK AND ADH METHODS. A COMPARATIVE STUDY**

Parallel determinations of the alcohol level were made in breath tests with an Alcohol Screening Device (ASD) based on electronic oxidation and in blood samples by the Widmark and ADH methods. Tests were performed on three volunteer males who had taken 0.75 grams of absolute alcohol per kilogram of body weight and on 46 persons suspected of drunken driving investigated during a weekend period. In cases where the blood alcohol level was below 1.5%, the results obtained from breath and from blood samples were in good accord, but when the blood alcohol level was over 1.5% the ASD method in nearly every case gave lower values than the determination from blood samples. The negative difference in these cases was up to 0.79%. In the case of the suspected drunken drivers, the ASD test did not give alcohol results reliable enough for use in court, but appeared to be a very useful and fairly quick method for a preliminary determination of the order of the blood alcohol level.

by A. Alha; K. Laiho; M. Linnoila  
Publ: Blutalkohol v12 n6 p360-4 (Nov 1975)  
1975 ; 1ref  
Availability: See publication; Antti Alha, Dept. of Forensic  
Medicine, Chemical Div., University of Helsinki, Kytoosuontie  
11, 00280 Helsinki 28 Suomi (Finland)

HS-018 722

## **THE ROLE OF DRIVER DEMERIT POINTS AND AGE IN THE PREDICTION OF MOTOR VEHICLE COLLISIONS**

The records of drivers selected from the file of licensed drivers in Ontario, Canada, were reviewed to study the relationship between demerit points, other driver characteristics, and the frequency or risk of future collisions and traffic convictions. A stratified sample of 500 to 600 drivers from each of five levels of demerit points was selected for the study. Low-point drivers were found to differ significantly from high-point drivers in age, sex, and class of license; estimates of the risk of collision or conviction in each demerit point group had to take account of these differences. Discriminant analysis was used to identify drivers likely to be involved in collisions or to have traffic convictions and to identify accidents involving injury or fatality. Of the traits considered, which included demerit points, age, sex, class of license, and previous accident record, demerit points represented the only variable of importance in predicting future collision involvement. Since this is the only one of these variables which can be altered by driver behavior, it offers an opportunity to prevent accidents.

by M. L. Chipman; Peter Morgan  
Publ: British Journal of Preventive and Social Medicine v29  
p190-5 (1975)  
1975 ; 7refs  
Supported by Traffic Injury Res. Foundation of Canada, Inc.  
and National Health Grant No. 605-7-746.  
Availability: See publication

## LIQUID-COOLED DISC BRAKES

The conventional disc brake can reach very high temperatures that seriously impair the brake performance despite the continuing development of better materials used as friction pairs. Lower temperatures can be obtained by using a fluid to remove much of the heat generated by friction. Thermal behavior of oil-immersed brakes is analyzed, and factors influencing the friction surface temperature and performance are discussed. Consideration is also given to the use of wet brakes in road vehicles. Liquid-cooled brakes offer considerable potential for development in commercial vehicle applications. These brakes have greater energy capacities than dry brakes and are flexible enough to vary the number of plates to cover a wide range of duties without loss of performance. They have further advantages of not requiring adjustment for lining wear and replacement is not necessary before an engine overhaul. Oil-immersed brakes extend the energy range that can be catered to by a friction brake with ease of serviceability, enabling them to meet the ever-increasing demands made by the increased vehicle loads and speeds.

by T. P. Newcomb; M. El-Sherbiny  
 Publ: Wear v34 n3 p311-7 (Oct 1975)  
 1975 ; 10refs

Presented at the International Tribology Conference (3rd),  
 "Tribology for the Eighties" Paisley, 22-25 Sep 1975.  
 Availability: See publication

HS-018 724

## METHODS FOR EVALUATING HIGHWAY SAFETY IMPROVEMENTS

A review of current highway safety improvement evaluation practices of highway agencies and an evaluation of the state-of-the-art were conducted. Library search was initially conducted to identify the current evaluation practices and a questionnaire was sent to 86 highway agencies to identify their current practices and any recently developed methods. A model system for evaluation of highway safety improvements that is readily adaptable to installation in a typical highway agency was then developed. This model system was developed to ensure that evaluations are made in their proper context and with the best available information. The model consists of the following six elements: identify hazardous locations; select alternative improvements; evaluate alternative improvements; program and implement improvements; evaluate the implemented improvements; and evaluate the highway safety program. The resultant Users' Manual was field tested in selected highway safety agencies to ensure its usefulness and readability. Further research is needed to develop a data base from which estimates of improvement performance can be made.

by John C. Laughland; Lonnie E. Haefner; Jerome W. Hall;  
 Dean R. Clough  
 Roy Jorgensen Associates, Gaithersburg, Md.  
 Rept. No. NCHRP-162 ; 1975 ; 156p 171refs  
 Sponsored by the American Assoc. of State Hwy. and  
 Transportation Officials in cooperation with the Federal Hwy.  
 Administration. Prepared in cooperation with the University of  
 Maryland and Washington Univ.  
 Availability: Transportation Res. Board, National Academy of  
 Sciences, 2101 Constitution Ave., N.W., Washington, D.C.  
 20418, \$7.40

## EMISSIONS FROM DIESEL AND STRATIFIED CHARGE POWERED CARS. FINAL REPORT

A total of ten passenger cars, four powered by diesel and six by stratified charge gasoline engines, one by a charge operating on gasoline and diesel fuel, two by equipped conventional engines, and one by a gas turbine, were subjected to a wide variety of emissions evaluations. Emissions were measured by the 1975 light duty Federal Test Procedure for gaseous emissions. Smoke and fuel consumption were also determined during the test cycle. Dynamometer versions of the 1974 heavy duty diesel and gaseous emissions tests were employed. Odor and instrumental-chemical measurements were made under steady-state and three acceleration conditions. The emissions of a low emission prototype Ford LTD and Chrysler LeBaron were limited to odor and related gaseous emissions. The prototype diesel odor analytical system was applied to exhaust from both diesel and gasoline engines. Its predictive method of diesel odor was investigated. No measurements were taken by the Society of Automotive Engineers driveby method as well as under a variety of exterior conditions. Comparisons of the results for all vehicles considered are by emission category. The emissions of a group of diesel cars are compared to the conventional cars. A stratified charge (PROCO) Capri, the Texaco stratified charge powered Cricket operated on gasoline and diesel fuel, and the Honda CVCC stratified charge engine are also included. Considerable data generated by the investigations are presented.

by Karl J. Springer  
 Southwest Res. Inst., 8500 Culebra Rd., San Antonio, TX 78284  
 Contract PH-22-68-23  
 Rept. No. AR-975; EPA-460/3-75-001a ; 1974 ; 328p 30 refs  
 Availability: Environmental Protection Agency, Office of Mobile Source Air Pollution Control, Alternative Auto Power Systems Div., Ann Arbor, Mich. 48105

HS-018 726

## A STUDY OF THE DIESEL AS A LIGHT DUTY POWERPLANT. FINAL REPORT

A study was conducted to determine if the diesel engine could be used as a viable power plant for an American passenger car. For the purposes of this study, the vehicle considered was a compact size sedan with "standard" performance characteristics. A literature survey covering existing light duty and heavy duty diesel literature was conducted and interviews were made to diesel manufacturers and users. Brief design studies were conducted to cover all the potentially viable power plants, which involved the calculation of performance and outline design of any type of diesel which could power a selected vehicle within the emissions targets of the Federal legislation. A rating methodology was derived which provided a numerical comparison of all the potentially viable power plants to be made. The results of these investigations were used to make recommendations for further action and to achieve the most desirable light duty vehicle. It was concluded that a diesel powered passenger car could be built with present technology. The vehicle would have equal acceleration and general performance of typical gasoline powered passenger cars, an acceptable noise level, a generally reduced smoke, and produce little if any visible smoke, and meet the primary emission targets without the use of catalytic converters.

other special equipment. The diesel powered vehicle would deliver up to 50% greater fuel economy than the equivalent gasoline engine vehicle, depending on the driving cycle. However, the study indicated that a diesel powered vehicle could not meet the secondary emissions target of 0.4 grams per mile of nitrogen oxides if the target vehicle and performance standards are adhered to and if current technology is assumed. Virtually no work has been conducted to determine the emissions capabilities of the light duty diesel for these secondary targets.

by C. C. J. French; M. L. Monaghan; R. G. Freese  
Ricardo and Co., Engineers (1927) Ltd., Bridge Works,  
Shoreham-by-Sea, Sussex, BN4 5FG, England  
Contract EPA-68-03-0375  
Rept. No. D.P.-18410; EPA-460/3-74-011 ; 1974 ; 324p 699refs  
Availability: Air Pollution Technical Information Center,  
Environmental Protection Agency, Research Triangle Park,  
N.C. 27711; NTIS

HS-018 727

#### **ROLLING RESISTANCE OF TIRES MEASURED UNDER TRANSIENT AND EQUILIBRIUM CONDITIONS ON CALSPAN'S TIRE RESEARCH FACILITY. FINAL REPORT**

Rolling loss tests were performed on 31 different passenger and four light truck tires on Calspan's Tire Research Facility (TIRF) under transient and equilibrium conditions. The tests were designed to determine the effects of load, speed, inflation pressure, tire temperature, slip angle, torque, tire construction, aspect ratio, and wheel diameter on rolling resistance. The influences of road curvature (flat roadway and drum) and trip length on rolling resistance were also investigated. The results, presented in tables and graphs, are expressed in terms of 12 power loss descriptors for each tire, stating initial values, equilibrium values, and distances required to achieve equilibrium, for rolling resistance, contained air temperature, tread surface temperature, and inflation pressure. The following observations were made: rolling loss data change exponentially with time; power loss data measured on the 67-inch drum were larger than corresponding data measured on the flat roadway, although the ratio is not constant for all tires; radial ply tires have significantly lower rolling resistances than bias ply and bias belted tires; for passenger tires, the equilibrium rolling resistance increases linearly with size; at constant tire temperature, the rolling resistance coefficient increases with load and road speed, while at equilibrium tire temperature it decreases; equilibrium rolling resistance decreases with inflation pressure; the rolling resistance of a radial ply tire tested under cornering conditions displayed two minima at -1.5 degrees and 2.5 degrees slip angle, in contrast to a bias ply and a bias belted tire of the same size, which showed only one minimum close zero slip angle; and the rolling loss of a braked/driven tire reaches a minimum under driving, not free-rolling, conditions.

by D. J. Schuring  
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221  
Contract DOT-HS-4-00923, AMEND. 2  
Rept. No. DOT-TSC-OST-76-9 ; 1976 ; 244p 12refs  
Report for Apr 1975-Jan 1976.  
Availability: NTIS

HS-018 728

#### **SPORTSMANLIKE DRIVING. TEACHER'S EDITION. 7TH ED.**

This textbook is designed to provide drivers with the knowledge they will need to make decisions that will enable them to move safely and efficiently within a traffic stream. The critical importance of information processing to driver performance is stressed. Emphasis is given to the concepts of developing an organized search for potential hazards, and separating and minimizing risks through the management of time and space. A procedure is developed for arriving at a compromise when multiple threats exist. Information covered in the text includes: introductory material on vehicle controls and predriving safety checks; basic manipulative skills; information processing procedures; vehicle law and performance; the influence of the roadway environment on traction and visibility; procedures for responding to system failures and coping with driver impairments; special problems of operating a motorcycle; and careers within the highway transportation system. This teachers' edition includes teacher notes and supplemental information designed to supply backup data for text statements and to identify points that should be emphasized. Student learning activities are also suggested.

by D. Eugene Gilmore, ed.; Paul Farrell, ed.  
American Automobile Assoc., Falls Church, Va.  
1975 ; 345p refs  
Availability: McGraw-Hill Book Co., Webster Div., New York

HS-018 729

#### **BICYCLE TRANSPORTATION PLAN AND PROGRAM FOR THE DISTRICT OF COLUMBIA**

A bicycle transportation plan was developed to serve three major goals: to provide bicycle accessibility to all major activity centers in the District of Columbia; to promote bicycle-user safety; and to facilitate bicycle parking. The plan and program include: a city-wide arterial network of 75 miles of continuous bikeways; a variety of bikeway types with a specific recommended type for each route; a supporting street improvements program which recognizes the importance of proper surfacing and maintenance of bikeways; a safety program directed at educating school children, motorists, and the general public; and a program that provides for parking in the downtown area, at bus stations and rail stations, at government locations, and in future centers of activity. A series of technical publications was also produced to assist city officials in the design and implementation of various elements of the plan.

Barton-Aschman Associates Inc., Washington D.C.  
1975 ; 34p  
Supported by the Federal Hwy. Administration and the District of Columbia Dept. of Highways and Traffic.  
Availability: District of Columbia Dept. of Highways and Traffic, Washington, D.C.

HS-018 730

#### **DRIVER IMPROVEMENT MEASURES: AN EVALUATION BASED ON CONVICTION AND CRASH RECORDS**

The processes utilized by the North Carolina Department of Motor Vehicles (DMV) to retard the accumulation of traffic

violations by drivers with incipient driving difficulty are evaluated. These processes are: the advisory letter sent to the driver after he accumulates seven points on his record; the individual meeting with a hearing officer; the driver improvement clinic itself; and the two types of curriculum utilized by the clinic instructors. Data utilized for the evaluation were from official driver records maintained by DMV. The main criterion variable used was average number of convictions (and crashes) in the year subsequent to the driver improvement measure under evaluation. Other criterion variables used were percentage of drivers conviction-free and crash-free in the subsequent year. These analyses were preceded by determining comparability of prior record of comparison groups. Analyses were done within age and sex groups. Results were not dramatic. However, based on convictions, trends favored clinic participants when compared with drivers assigned to the clinic but not attending or completing the course. The finding was not consistent for all age and sex groups. It is emphasized, however, that the value of a driver improvement program probably cannot be judged solely on citation and collision data.

by Elizabeth G. House; Patricia F. Waller  
University of North Carolina, Hwy. Safety Res. Center,  
Chapel Hill, N.C.  
1976 ; 82p 9refs  
Partially supported by the North Carolina Governor's Hwy.  
Safety Prog.  
Availability: Corporate author

## DEVELOPMENT AND EVALUATION OF THE NORTH CAROLINA PICTORIAL ORAL DRIVER LICENSE EXAMINATIONS

A need was identified for developing new driver license knowledge tests for use with applicants unable to read well enough to take the written version of the North Carolina test. The development and evaluation of new pictorial oral exams are discussed. Each test item was presented pictorially with the driver license examiner explaining the question and the answer choices to the applicants. There was considerable input from driver license examiners as well as others in the development of the pictorial items. Special data were collected from the field shortly after the new tests were introduced by means of workshops, evaluations, and applications involving a number of driver license examiners. Information on driver license renewal applicants was linked to their prior driver records, and a variety of psychometric analyses were performed. It was found that: the oral exam applicants are generally older, much more likely to be male, much less likely to be white, and not as well educated as written exam applicants; the oral tests seem to be slightly less difficult than the written; test reliabilities are all at an acceptable level; the test items are at an acceptable level of difficulty; the tests seem to be assessing one general set of knowledge but from a variety of independent aspects; situational questions dealing with predicaments in which the driver may find himself were more predictive of driver record variables than other types of test questions; and the relationship between test performance and driver record variables appears stronger for reckless violations

and for accidents than for other violation types or other factors.

by Patricia F. Waller; Robert G. Hall; Henrr A. Lower  
Laura B. G. Nathan  
University of North Carolina, Hwy. Safety Res. Center,  
Chapel Hill, N.C.  
1976 ; 52p 6refs  
Supported in part by the Governor's Hwy. Safety Prog.  
Availability: Corporate author

## THE MEASUREMENT AND INTERPRETATION OF SPEED-FLOW RELATIONSHIPS

The four main types of sampling procedure used to determine the average speed and flow of traffic travelling in a given direction, sampling in time, in space, jointly in space and time, and the "moving observer" method, are discussed. Previous reported experiments conducted on a two lane rural road in England to measure the effect of varying the size of the sampling interval on the coefficients of the regression equations of time-mean speed on flow measured at a point are illustrated. It is concluded that: observations of speeds and flows may be regarded as random variables with a joint probability distribution, whose parameters are estimated with the type of sampling procedure, the size of the sample, and possibly with the average level of flow during the sampling period; for the purpose of predicting the average flow over a relatively long, continuous period on a specific section of road, any difference between the type and size of domain used in estimating the prediction equation space/time area for which the prediction is required is weighed; for speed and flow relationships either at a point or at an instant of time, it may be taken that only if there is a substantial difference in the order of magnitude of the quantities, will there be any likelihood of significant error; where the sampling procedure involves measurement in space/time domains, there is a risk that the serial correlations between the observations may be of a higher order than otherwise, and consequently the error in varying the size of the sample may be more serious. It is concluded that: the representation of speeds and flows by a bivariate linear autoregressive process may be a useful method for predicting indirectly the slope of the regression line that would have been obtained for sampling intervals of a fairly large size.

by C. C. Wright; T. Hyde  
Publ: Traffic Engineering and Control v13 n12 p507-11  
(Mar/Apr 1972)  
1972 ; 4refs  
Availability: See publication

## THE CONTROL OF RIGHT-TURNING VEHICLES AT SIGNAL-CONTROLLED INTERSECTIONS: TWO OPPOSING VIEWS

Comments on a proposed new method for the control of right-turning traffic at a signalized intersection are presented. The method insures that traffic effectively makes its right turn

ational traffic layouts that were claimed by its authors. For conventional layouts, a delay-minimizing program was used to produce optimal signal settings and minimum delays, and, for the new layout method, a formula for right-turn delay was developed and used in a general purpose function-minimizing subroutine to determine optimal signal settings and minimum delays. Diagrams of the T-junction on which the comparison was performed and the signal phasings which were compared are provided. Results clearly support the proposed new method, showing a great increase in capacity for right-turners and corresponding reduction in delay, particularly at high flows of right-turners. The developed formula for right-turn delay is presented and its derivation is appended. Full-scale trials of the proposed new method are recommended as worthwhile.

by T. P. Hutchinson; Susan Jourdain  
Publ: Traffic Engineering and Control v15 n20 p920-4 (Dec 1974)  
1974 ; refs  
Includes "A Comment on a Suggestion by Al-Salman and Salter" and "The Operation of Signals to Rechannel Right-turning Vehicles."  
Availability: See publication

HS-018 734

#### **ACCIDENTS TO PEDESTRIANS AND ENVIRONMENTAL EVALUATION: PROVISIONAL PREDICTIVE MODELS BASED ON THE SHEFFIELD/ROTHERHAM AREA**

An exploratory study was conducted in an effort to derive predictive models for pedestrian accidents (all severities) for use in the strategic evaluation of alternative transportation plans. The mathematical model developed was based on link-by-link data collected from the Sheffield/Rotherham area of London, England, in which the number of accidents to pedestrians was treated as the dependent variable. It was assumed that factors such as traffic volume, layout and land use, and pedestrian numbers on pavements and/or crossings together largely explain the variations which occur in accident rates per unit length of network road. Suitable data was obtained for a 30% sample of the Sheffield/Rotherham transportation network and a series of regression equations was derived. Data collected on the 401 network links selected included: numbers and types of accidents; traffic volumes and composition, including numbers of busses; selected road layout and land use, particularly the amount of shopping floor space; and pedestrian traffic generating characteristics. It was found that an equation which predicts the accident rates from data on off-peak traffic volumes, shopping floorspace, hourly flow of busses, and pedestrian density could be used in a model to predict the overall accident rate for the system of 400 links to within plus or minus 0.45 accidents per year per kilometer. However, application of the model to predict accidents on a single link of the network resulted in an unacceptably high rate of errors. It is concluded that while deriving models for use in evaluations of alternative transport plans has been shown to be a practicable aim, much further work is needed to refine the models. It seems likely that different models will be needed for differing types of urban areas.

by D. H. Crompton; D. L. Warriner; J. Goldschmidt  
Imperial College, Dept. of Civil Engineering, London  
1976 ; 19p  
Sponsored by DoE, England.  
Availability: Corporate author

HS-018 735

#### **ACE. ACCIDENT COUNTERMEASURE EVALUATION SYSTEM OVERVIEW**

The Accident Countermeasure Evaluation (ACE) System is described. The ACE is a computerized method for evaluating accident countermeasures which have been implemented at specific locations or areas. Copies of the following reports are included: an Alabama traffic accident report; a complete before and after accident countermeasure evaluation report for one location; a complete location comparison report; and other programmed outputs.

by George Roland Herran, Jr.  
Auburn Univ., Dept. of Industrial Engineering, Auburn, Ala. 36830  
Rept. No. 300-76-002-001-033 ; 1975 ; 79p 7refs  
Sponsored by a grant from the Alabama Office of Hwy. and Traffic Safety. Prepared in cooperation with the Alabama Hwy. Dept.  
Availability: Corporate author

HS-018 736

#### **DRIVER EDUCATION AND DRIVING OFFENCES IN YOUNG MALES**

Some of the literature on driver education schools is summarized and cost-benefit is discussed. The records from a high school in Tasmania, with a compulsory driver education program involving 200 students are compared with those from four other high schools (800 students involved) on which a similar study was conducted. The driver education course studied reduces the types and varieties of traffic offenses most frequently shown by those of lesser intelligence in the four high schools. It also reduces the non-moving offenses in those of higher intelligence. The initial skills gained from the course by those of lower intelligence are partially lost within two years and if the rate of diminution continues will be eliminated in four years. Pupils of the Tasmanian high school driver education course and another school in a similar socio-economic category were shown to have been convicted of fewer offenses than were those from the other three schools in which the records were analyzed. Learning and language difficulties and their possible importance are discussed as a factor in traffic offenses. Some "reportable accident" figures in connection with these studies are included in an appendix. Socio-economic factors seem to be of as great an importance in accidents as is driver education.

by L. Boyce; E. Cunningham Dax  
Austrian Road Research v5 n7 p24-43 (May 1975)  
1975 ; 21refs  
Availability: See publication

HS-018 737

#### **IMPLEMENTATION OF PROVEN TECHNOLOGY IN MAKING THE HIGHWAY ENVIRONMENT SAFE**

The results of an attempt to identify factors limiting the application of known technology for making highways safer and to develop strategies for achieving greater application are reported. The project included four primary tasks: a literature search conducted to determine highway design programs effective in reducing either accident incidence or severity and cost-effective; an economic analysis involving the creation of pri-

ority ranking of cost-effective programs; a determination of problems in information dissemination and program implementation; and the development of strategies for overcoming these problems.

by Forrest M. Council; William W. Hunter  
University of North Carolina, Hwy. Safety Res. Center,  
Chapel Hill, N.C.  
1975 ; 258p 176refs  
Supported by funds under Motor Vehicle Manufacturers  
Assoc. Agreement No. UNC-7403-C5.4.  
Availability: Corporate author

HS-018 741

## **MATHEMATICAL MODELS FOR PREDICTION OF FUEL TANK AND CARBURETOR EVAPORATION LOSSES**

A comprehensive method for predicting the mass and composition of evaporative losses from fuel tanks and carburetors and a computer program embodying the method are presented. The method is presented as a tool to assist in the design and evaluation of fuels and vehicle evaporation control systems, not as a substitute for compliance testing. The prediction method makes use of published equations for carburetor loss, tank loss, and loss composition. Calculated losses are compared with measured losses from several published studies. The accuracy and limitations of the method are described, and some relationships between losses and fuel and fuel system parameters are shown.

by W. J. Koehl, Jr.  
Mobil Res. and Devel. Corp., Res. Dept.  
Rept. No. SAE-690506 ; 1969 ; 32p 9refs  
Presented at the Mid-year Meeting, Chicago, Ill., 19-23 May 1969.  
Availability: SAE

HS-018 742

## **THE AUTOMOTIVE TUBE AND FIN AIR CONDITIONING CONDENSER**

The general design requirements of an automotive air conditioning condenser and some specification requirements it must meet are described. One type of automotive tube and fin condenser being built today is presented. The process from raw material to shipping with performance data showing the effects of capacity when using different tubing material is discussed. A brief description of different fin arrangements currently in automotive use, with some basic information is also presented. It is concluded that the tube and fin condenser has been a very satisfactory vehicle component from cost, performance, and durability standpoints. Its flexibility in using a variety of tubing material and circuiting, and its ability to meet the durability required in vehicle operation indicate it will be in use for some time to come.

by William Melnyk  
McCord Corp., Heat Transfer Div.  
Rept. No. SAE-690512 ; 1969 ; 6p  
Presented at the Mid-Year Meeting, Chicago, Ill., 19-23 May 1969.  
Availability: SAE

HS-018 743

## **THE PREKNOCK KINETICS OF ETHANE IN A SPARK IGNITION ENGINE**

The construction of a model describing the chemical reactions occurring in the fuel-air mixture prior to the arrival of an engine and the integration of the energy equation, the rates of reaction as predicted by this model, over air mixture history, are explained. The kinetic model of sudden oxidation of the fuel in terms of the order and magnitude of knock experimentally observed using ethane in a CFR engine.

by David R. Trumpy; O. A. Uychara; P. S. Myers  
Shell Res. Labs.; University of Wisconsin  
Rept. No. SAE-690518 ; 1969 ; 24p 68refs  
Presented at the Mid-Year Meeting, Chicago, Ill., 19-23 May 1969. Supported by the Ethyl Corp., University of Wisconsin Graduate School and the Engineering Experiment Station. Prepared in cooperation with H. Newhall and A. Quadagno. S. C. Sorenson.  
Availability: SAE

HS-018 744

## **STEADY-STATE CORRELATION OF DIESEL SMOKE METERS--AN SAE TASK FORCE REPORT**

An experimental investigation to establish correlations between diesel smoke meters is described. Correlations between sampling meters (the Bosch spotmeter and Hartridge meter), opacity meters (United States Public Health Service meter and the Beckman 912 meter) and exhaust content are presented. All meters were compared to the spotmeter system. Sampling meters were placed at the stack outlet and the optical axes of the opacity meters centered about four inches above the stack outlet. Correlation curves for the correlations among the various meters and between exhaust spot content and between the various meters themselves are presented.

by A. W. Carey, Jr.  
Cummins Engine Co., Inc.  
Rept. No. SAE-690492 ; 1969 ; 5p 4refs  
Presented at the Mid-Year Meeting, Chicago, Ill., 19-23 May 1969. Research conducted by an SAE task force.  
Availability: SAE

HS-018 745

## **SOME ASPECTS OF METRICATION IN BRITAIN**

An evaluation of the metric system within the United Kingdom is presented. Psychological, administrative and technical aspects are discussed. At the present time the British government supports the metric change, but the industry on industry to execute the program. Implementation of publicity of metrication is discussed in terms of industry and general acceptance.

by Ewen McEwen; F. E. Butcher  
Joseph Lucas Ltd.  
Rept. No. SAE-690447 ; 1969 ; 8p  
Presented at the Mid-Year Meeting, Chicago, Ill., 19-23 May 1969.  
Availability: SAE



## N CONDITIONS IN DIESEL ENGINES

A theory applicable to wide range of problems from firing behavior to combustion efficiency of extreme firing in supercharged engines is presented. The theory relates cetane number with the time/temperature integral of combustion cycle and emphasizes the need for quick and combustion of a large amount of fuel in a geometrical space. The following tentative conclusions pertain to combustion in pressure charged, very high output engines: the average excess air of combustion should be 10% to prevent "choking" the fuel that enters late in the injection period; the injection period should not exceed 10% of the cycle; the pronounced pressure rise in the indicator should not occur before 10° btdc; a reversed shape of the rate by starting fast and reducing the rate toward the end is recommended in contrast to the conventionally angular shape of an increasing rate of injection; the use of a rigid injection mechanism, hydraulic as well as mechanical, will require renewed attention; abundant and uniform air movement, preferably in the form of charge rotation, should be adjusted to shorten the "tail" of the heat release curve peeling adherent layers of liquid and evaporated fuel; and the amount of fuel hitting the walls, the cylinder head, and the air movement that heats and picks up the fuel will influence the oil dilution at idle and low load and at higher loads.

Author: S. J. Pachernegg

Title: Prof. List, Austria

Report No.: SAE-690253; 1969; 22p

Presented at the International Automotive Engineering

Congress, Detroit, Mich., 13-17 Jan 1969.

Availability: SAE

748

## EVALUATION OF AIR CHARGE TEMPERATURE INJECTION FOR SEVERAL FUELS IN A DIESEL ENGINE

A study of the relation between the ignition delay, based on the start of combustion, rise due to combustion, and the mean air charge temperature has been obtained for diesel, gasoline and Compression-Turbine-Engine (CITE) fuels. Experiments were carried out on a single cylinder open combustion chamber engine, with an intake air temperature varied over a range from atmospheric to about 750°F. The experimental results indicated: the pressure rise delay decreases continuously with increase in the air charge temperature; the rate of pressure rise in the pressure rise delay is greatest for gasoline, followed by CITE and diesel fuels; and that while there is a great difference between the pressure rise delay of fuels at temperatures corresponding to those occurring in naturally aspirated engines, these fuels exhibit nearly equal delay periods at temperatures higher than 600°F. It was also found that the correlation for pressure rise delay for the three fuels and the rate of pressure rise with the mean integrated temperature of the charge. The correlation has the form of the Arrhenius equation, which has proven to be successful in correlating chemical reaction rates with temperatures. The activation energy was found to be constant for the fuels over the temperature range of interest for naturally aspirated and highly supercharged diesel engines. Gasoline had the lowest activation energy, and CITE had the lowest. A straight line relationship was found to exist between the apparent ac-

tivation energy and the cetane number of the fuel. With the formulas obtained from this study, it is possible to compute the ignition delay of the fuel from its cetane number. However, it should be noted that the study was made at a mean pressure of 700 pounds per square inch atmosphere, during the ignition delay. Additional testing would be desirable to determine the effect of changing the pressure on the present correlations, and to examine their validity in other open chamber designs.

by N. A. Henein; Jay A. Bolt

University of Michigan, Dept. of Mechanical Engineering

Rept. No. SAE-690252; 1969; 16p 42refs

Presented at the International Automotive Engineering

Congress, Detroit, Mich., 13-19 Jan 1969.

Availability: SAE

HS-018 749

## COMPUTER CONTROL OF MOTOR GASOLINE BLENDING

The Baton Rouge Refinery of Humble Oil and Refining Company is implementing an advanced computer control system on their new in-line motor gasoline blending facilities. The complexities of gasoline blending which dictates the use of both off-line and on-line computers are described, including: uncertainties in shipment force; and the large number of grades produced by the blending operation. Major functions of the computer system in providing smooth-running operations include: planning; scheduling; optimization; and control of all motor gasoline blending operations within the refinery. Three digital computers are involved, as well as an extensive communications network, and some advanced on-line analyzers. The project is illustrative of a multilevel, multicomputer control system which has been designed to solve a number of complex problems for a number of different users within the refinery.

by R. W. Weiland

Humble Oil and Refining Co., Baton Rouge, La.

Rept. No. SAE-690226; 1969; 9p

Presented at the International Automotive Engineering

Congress, Detroit, Mich., 13-17 Jan 1969.

Availability: SAE

HS-018 750

## APPLICATIONS OF AUTOMATIC PROCESS CONTROL TO ENGINE DEVELOPMENT TESTING

Internal combustion engines are developed from two standpoints. Engine performance characteristics must be made attractive to users, and the physical parts of the engines must be brought to a standard of durability which insures the user of full performance over a reasonable life. Performance testing involves large quantities of accurate data, calculation, and plotting. A comprehensive data acquisition system has been on-line for two years servicing five gas turbine test cells and six diesel engine dynamometer rooms. The system has proven to be fast, accurate, and adequately flexible. In durability testing, where the accent is on test hours rather than data, a different approach results in a less costly system. Patterned after a hard wired system installed in 1958, a computer controlled system is being installed to service 13 new durability test stands which makes use of magnetic storage and provides signals for test control. Experience with these systems has

been such that no new facility has been considered in the last few years without automatic data handling being planned into it. Justification for this type of equipment is easier when a new laboratory or an expansion is planned. Except for the very smallest, each system needs custom design and the results will depend upon how well the user understands and describes the job to be done.

by Roger Wellington  
General Motors Corp., Detroit Diesel Engine Div.  
Rept. No. SAE-690227; 1969; 8p 3refs  
Presented at the International Automotive Engineering Congress, Detroit, Mich., 13-17 Jan 1969.  
Availability: SAE

HS-018 751

## ADVANCED COATINGS ON SUPERALLOY BLADES AND VANES FOR HOT CORROSION AND OXIDATION RESISTANCE

The need for surface protection of nickel base alloys to prevent hot corrosion and/or sulfidation is discussed. Test rigs, utilizing 8-16 airfoil shaped paddles or standard T56 engine turbine blades as specimens, are run in cycles consisting of heating the rotating test specimens, then coating them with a sodium sulfate solution. Uncoated materials, by comparison, are evaluated by the weight loss method, and coated alloys are evaluated by number of cycles required to cause coating breakdown. The relative corrosion resistance of a number of commercial alloys is shown, and the response of these alloys to corrosion resistance with protective coating is covered in relation to their limitation in erosion/oxidation deterioration. Coating processes include: the pack process; the vapor process; and the electrophoretic process with the Allison diffused aluminum coatings. Apparently the Allison electrophoretic process is most successful due to: uniform and full coverage by the coating due to the precise nature of the process; versatility in depositing a wide range of elements and their components simultaneously and prior to diffusion; and potentially reduced costs over hot dip or pack processes.

by D. K. Hanik; O. O. Shockley; J. O. Hodshire  
General Motors Corp., Allison Div.  
Rept. No. SAE-690480; 1969; 8p 4refs  
Presented at the Mid-Year Meeting, Chicago, Ill., 19-23 May 1969.  
Availability: SAE

HS-018 752

## INSIDE CAR SAFETY. ACCIDENTS AND CONSEQUENCES [INNERE SICHERHEIT IM AUTO. DAS UNFALLGESCHEHEN UND SEINE FOLGEN]

Case studies of more than 100,000 car accidents involving injuries to occupants were made to determine the relation between accident type, damage severity, and occupant injuries. A total of 28,936 accidents yielded data accurate enough for the accidents to be subjected to thorough scientific analysis. General data on accident development include: accident type; speed; driver reaction; accident locations; time of accident (including month, day of week, and time of day); and rollover, single vehicle, and fire accidents. Occupant data include: number of occupants; seating position; injuries by seating position; sex; and age of injured driver and passengers. Vehicle damage information covers: damage severity definition and relation to

accident type (collisions with other vehicles and with fixed objects); and partial damage such as engine shift, doors popping open, damage to windows, windshield, and frame, steering wheel and column, dashboard, glove compartment, front seats, and other operating elements. The role of each in injury causation is given. Injury severity is dealt with in relation to accident type, vehicle weights, and body area (including head, thorax, abdomen, shoulder, arm, hand, leg, knee, foot, and spinal column). Injury reduction due to headrest and seat belts is commented on. Findings include: unbelted occupants can be fatally injured at speeds as low as 20 km/hr; 62% of the reported accidents occurred in towns and 49% took place at intersections; the left front of the vehicle is damaged in 59.5% of passenger car collisions; the percentage of fatal injuries in collisions between passenger cars and trucks is 2.7 times greater than in car to car collisions, and 6 times greater in collisions with trees; higher vehicle occupancy is related to more serious accidents and those involving rollover; children have a higher injury risk and suffer head injuries far more often than adults; and the risk of serious injury is reduced by at least 50% when seat belts are used.

Association of Liability, Accident, and Motor Transportation Insurers, Inc., (HUK Assoc.), Hamburg, (West Germany)  
1975; 266p 19refs  
Text also in German.  
Availability: Corporate author

HS-018 753

## THE APPLICATION OF NMR SPECTROSCOPY TO THE ANALYSIS OF AUTOMOTIVE PLASTICS

The application of proton and carbon-13 nuclear magnetic resonance (nmr) spectroscopy to the analysis of selected automotive plastics is discussed. Six nmr spectra are presented and the chemical shift values assigned to structural features for each polymer. The utility of nmr analysis for the characterization of organic polymers is illustrated by the application to the identification of polycarbonate thermoplastic and a polyurethane elastomer and to the determination of the stereochemical configuration of poly (methyl methacrylate).

by John E. Over  
Mobay Chemical Corp.  
1975; 9p 8refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 754

## IMPROVED NITRILE RUBBERS WITH POLYMERIZATION BOUND ANTIOXIDANT STABILIZATION

The work that has led to the development of a new family of unique polymerization bound antioxidant stabilized nitrile rubbers which have outstanding heat resistance characteristics is discussed. These new rubbers also retain their age resistance characteristics after exposure to oils or fuels which can extract

the protective antioxidants from conventional nitrite rubbers thereby contributing to early failure of parts in service.

by James W. Horvath  
Goodyear Tire and Rubber Co.  
Rept. No. SAE-750960 ; 1975 ; 10p 10refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 755

## **THE LONG-TERM HEAT RESISTANCE OF EPICHLOROHYDRIN HOSE AND TUBING COMPOUNDS**

Some of the compounding techniques necessary to develop the best long-term heat resistant epichlorohydrin compounds are reviewed. The long-term (1000 hours) aging resistance of these materials is compared to more conventional materials such as CR, NBR, CSM, and EPDM compounds. Blends such as Acrylate/Epichlorohydrin and Epichlorohydrin/Chlorobutyl are reviewed as ways to obtain a balance of heat resistance and cost. The results of studies of various compounding ingredients, information on CO/ECO blends, the effects of air oven versus air test tube aging, information on Acrylate/Epichlorohydrin and Epichlorohydrin/Halobutyl blends, and the recipes and long-term air aging data on heat resistant hose and tube compounds of various polymers are tabulated. Tests were run on slabs or buttons press cured according to conditions described in the tabulations.

by J. T. Oetzel  
B. F. Goodrich Chemical Co.  
Rept. No. SAE-750961 ; 1975 ; 21p  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 756

## **ETHYLENE PROPYLENE ELASTOMER TECHNOLOGY FOR IMPROVED HIGH TEMPERATURE SERVICEABILITY**

Most established heat aging analyses rely on separate treatment of two parameters, retention of tensile strength or retention of elongation, to predict acceptable elastomer performance. A method with which to study aging behavior combining these parameters into a single expression, the fractional strain energy at break, which describes an aged vulcanizate in terms of both its integrity (retained tensile) and extensibility (retained elongation) is discussed. Use of fractional strain energy at break is shown to be a reliable means of characterizing and projecting ethylene propylene (EP) aging behavior. Compounding principles which affect EP long term heat resistance are demonstrated. These include the importance of the proper vulcanization system, the effects of different fillers and plasticizers, the original quality level of the vulcanizate, and the selection of special additives to improve aging. Most of the data presented feature terpolymers, which offer a good balance between heat resistance and compounding versatility. However, for those EP uses which require maximum long

term, high temperature resistance, it is shown that the best serviceability is achieved with EP copolymers.

by R. S. Auda; D. R. Hazelton  
Exxon Chemical Co., Elastomers Technology Div.  
Rept. No. SAE-750962 ; 1975 ; 27p 15refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 757

## **DRIVER-VEHICLE PERFORMANCE IN CLOSED LOOP TESTS**

Closed-loop maneuvers were performed by a cross-section of typical drivers (32 subjects in all) in four representative automobiles (a Volkswagen Superbeetle, a Ford Custom sedan, a Pontiac Trans-Am, and an Oldsmobile Toronado). The tests included both preplanned control tasks and spontaneous reactions to sudden obstacles or visual instructions. Maneuvers included: trapezoidal steer, braking in a turn, road holding in a turn, sinusoidal steer, and drastic brake and steer. The surprise conditions included: sudden obstacle, lane decision at intersection, late decision at freeway exit, blind corner, and sudden lane change. On the average, the drivers did not achieve the open-loop limit performance of the cars. Directional response parameters were the more significant indicators of differences in performance between vehicles.

by Gordon G. Hayes; Rodger J. Koppa; J. Tom White;  
Monroe C. White  
Texas A and M Univ., Texas Transportation Inst.  
Rept. No. SAE-750964 ; 1975 ; 8p 4refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 758

## **CUMULATIVE FATIGUE DAMAGE ANALYSIS OF A LIGHT TRUCK FRAME**

A fatigue damage analysis of a light truck frame to determine whether an existing frame design can safely accept a ten percent increase in load is described. The analysis incorporates an experimental stress-strain analysis, proving ground test data and experimentally determined properties of the frame material. Three common methods of damage analysis and a relatively new procedure are compared and the advantages of the new method are demonstrated. It is concluded that: both the stress and strain-based approaches appear to be adequate for the relative ranking of the design for this particular loading history; the computer approach which employs a cyclic stress-strain relationship, a more complete representation of the fatigue response of the metal, and direct strain-time histories at critical locations best predicts the experimental results; and the original design of the light truck frame will perform adequately under the increased load.

by M. R. Mitchell; R. M. Wetzel  
University of Illinois; MTS Systems Corp.  
Rept. No. SAE-750966 ; 1975 ; 13p 33refs  
Presented at the Automobile Engineering Meeting, Detroit,  
Mich., 13-17 Oct 1975.  
Availability: SAE

## PROBLEM AREAS IN SAMPLING AND ANALYZING VCM [VINYL CHLORIDE MONOMER]

Attempts are made to define some of the problem areas regarding vinyl chloride monomer (VCM) sampling methods and analytical procedures. It can be concluded that: the fabricating plant can control emissions from PVC processing with well designed ventilation systems and good housekeeping though the final solution should be eliminating the problem at the source; the required accuracy can be achieved only with extreme care at each step from the monitoring through the analysis; and the number of steps in the analysis should be reduced to minimize the chance for errors.

by Howard E. Williams  
McCorr Corp., Davidson Rubber Co.  
Rept. No. SAE-750969 / 1975 ; 6p 3refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 760

## THE FATIGUE LIFE OF VEHICLE FRAME STRUCTURES

The stresses arising in a vehicle structural part during the operation period are discussed. These can be divided into three essential components: the initiation of fatigue crack; crack propagation under varying stress history; and unstable crack propagation. The derivation of the extreme values of these components and their distribution function is shown. Using appropriate crack propagation functions, the momentary service strength of the structure and the damage-function is defined. On the basis of the new fracture model presented, the life distribution can be interpreted unambiguously. By using certain assumptions, the average value and the scatter of the life can be derived. The new fracture model allows the several fracture types, like static, pure dynamic, pure fatigue, and general fractures to be treated on the same basis.

by Matolcsy Matyas  
Repsent Inst. of Automobile Industry, Hungary  
Rept. No. SAE-750968 / 1975 ; 18p 3refs  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 761

## MATERIAL ALTERNATIVES FOR TODAY'S EMISSION CONTROL SYSTEM

Two recently developed sheet products offering material cost savings opportunities of about \$2.50 per typical car with a catalytic conversion system are discussed. Galvalume sheet steel, an aluminum-zinc alloy coated sheet, has been used successfully for grass shields replacing type 1 aluminum coated sheet at an approximate savings of 25 cents per pound. Chromized sheet, which has a diffused layer of ferritic stainless steel on both surfaces of a special low carbon sheet, is suggested as a substitute for 400 Series Stainless Steel at a material cost benefit of about 15 cents per pound. Exhaust inlet tubes and converter shells of Chromized sheet steel have been successfully tested. Photographs of applications of these

sheet steels and graphs and photographs comparing them to their suggested predecessors are included.

by D. E. Blandy, Jr.  
Bethlehem Steel Corp.  
Rept. No. SAE-750972 / 1975 ; 8p  
Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.  
Availability: SAE

HS-018 762

## AUTOMOTIVE DESIGN AND MATERIALS SELECTION

Solutions to the problems of material supply and selection in automotive design are discussed. The solutions will require more material substitution for given applications. It is concluded that the application of the three-dimensional concept measuring geological availability, economic availability, and interchangeability appears the best method for optimizing the use of the materials which can be delivered by the supply system.

by James Boyd  
Materials Associates, Inc.  
Rept. No. SAE-751005 / 1975 ; 7p  
Presented at the SAE Detroit Sec. Meeting, Detroit, Mich., 11 Feb 1975.  
Availability: SAE

HS-018 763

## THE ISO STANDARD GUIDE FOR THE EVALUATION OF HUMAN EXPOSURE TO WHOLE-BODY VIBRATION

The present international guide for the evaluation of human exposure to whole-body vibration, which is based on all relevant information presently available and reflects the best judgement of all experts and disciplines involved, is discussed. Some of the decisions underlying the standard and future work on vibration exposure standards are considered. For the present time the evaluation of vibration environments, occupational as well as recreational, and the testing of equipment and machinery with respect to its effect on man are best accomplished by means of the existing standard.

by H. E. von Gierke  
Aerospace Medical Res. Lab., Wright-Patterson AFB, Ohio  
Rept. No. SAE-751009 / 1975 ; 10p 34refs  
Presented at the Truck Meeting, Philadelphia, Pa., 10-13 Nov 1975.  
Availability: SAE

HS-018 764

## THE EFFECT OF "S" CAM BRAKE COMPONENT VARIATION ON PERFORMANCE

The interrelationship of the brake lining with other brake components as affected by structural and dimensional variations of the braking components is discussed using the "S" cam foundation air brake as an example. Linings, shoes, the cam, cam rollers, drums, structural components, and dynamometer testing are all discussed as part of the conformance with Federal Motor Vehicle Safety Standard 121. The re-evaluation of the

brake blocks part of the "S" cam foundation air brake system established new understanding of component variation and interactions on performance. Each of the significant components must be understood and controlled to obtain desired performance consistency. It is concluded that the simple "S" cam brake is actually a complex system of variables requiring cautious evaluation.

by Paul A. Myers

R/M Friction Materials Co.

Rept. No. SAE-751012; 1975; 10p

Presented at the Truck Meeting, Philadelphia, Pa., 10-13 Nov 1975.

Availability: SAE

HS-018 765

## **EVALUATION OF GRAY IRON BRAKE DISCS FOR TRUCKS BY THERMAL MODELING**

An investigation studying design improvements of brake disks for trucks is presented. An analytical thermal model was developed. The model employed the lumped parameter approach, in which the disk was subdivided into a number of small volumes. The model specifically simulated disk temperature response during 50 mph dynamometer fade tests. The braking schedule consisted of a simulated 9 foot per second per second deceleration from 50 mph to 15 mph, followed immediately by a 0.66 foot per second per second acceleration back to 50 mph. The thermal model was correlated with test data to verify and improve its accuracy, and then utilized to evaluate effects of geometry changes. Results showed that mass concentration in the disc faces yields lower temperatures at the friction interface through 10 successive fade tests. Even after a very large number of such decelerations, temperature cycling would be less extreme with thicker faces. It is concluded that thermal modeling is a valid and potentially valuable tool in the design optimization of brake discs. A nodal map of a brake disc section and disk face temperature and thickness variation curves are provided.

by H. W. Schwartz; L. L. Hartter; S. K. Rhee; J. E. Byers  
Bendix Corp.

Rept. No. SAE-751013; 1975; 12p 14refs

Presented at the Truck Meeting, Philadelphia, Pa., 10-13 Nov 1975.

Availability: SAE

HS-018 766

## **COOLING ANALYSIS OF DISC BRAKE ROTORS**

Equations for determining the convective heat transfer coefficients of solid and ventilated disc brakes are presented. Analysis of data indicates that the cooling capacity of a ventilated rotor is sharply reduced at lower speeds, and most cooling is provided by the increased surface area. A general relationship derived from road test data (heating the brakes to about 700°F and measuring the subsequent cooling at constant vehicle speeds ranging from 10 to 50 mph) is presented that yields the heat transfer coefficient for both disc and drum brakes of commercial vehicles.

by Rudolf Limpert  
University of Utah, Mechanical Engineering Dept.

Rept. No. SAE-751014; 1975; 8p 5refs

Presented at the Truck Meeting, Philadelphia, Pa., 10-13 Nov 1975.

Availability: SAE

HS-018 767

## **THE INFLUENCE OF SIZE ON THE RECOGNITION OF SYMBOLS FOR MOTOR VEHICLE CONTROLS**

A total of 16 male drivers with a median age of 39.4 years searched for known symbols on a simulation of a dimly lit instrument panel. The symbols, from 2 millimeters (mm) to 25 mm in diameter, were in groups of nine. They were randomly selected from 24 symbols used to identify controls and displays on European Ford vehicles. The probability of recognition was related to size for eight symbols. This gives a rational basis for the size used in vehicles. No reliable difference was found between the performance of black symbols on white backgrounds and white on black. Substantial differences exist between the effectiveness of different symbols. Recommendations for improvements based on confusions between symbols were made for the following: the window lift, sliding roof, windshield and backlight heaters, wiper, air conditioner, fog light, main beam, hood release, and instrument light symbols.

by Gordon R. W. Simmonds

Ford of Britain

Rept. No. SAE-740997; 1974; 11p 7refs

Presented at the Automobile Engineering Meeting, Toronto, Canada, 21-25 Oct 1974.

Availability: SAE

HS-018 768

## **THE APPLICATION OF THERMOGRAVIMETRY TO THE EVALUATION OF AUTOMOTIVE PLASTICS**

The application of the thermal analysis technique, known as thermogravimetry, to the problems of fast quality control analysis of automotive plastics is discussed. Specific examples in the areas of relative thermal stability, analysis of additives, and compositional analysis of formulations are presented. Also included are various thermogravimetric curves for different plastics.

by Stephen J. Swarin

General Motors Res. Lab.

Rept. No. SAE-750939; 1975; 10p 18refs

Presented at the Automobile Engineering Meeting, Detroit, Mich., 13-17 Oct 1975.

Availability: SAE

HS-018 769

## **WHOLE BODY RESPONSE RESEARCH PROGRAM. SECOND YEAR FINAL REPORT**

Progress of a program to obtain data on human whole body kinematics under controlled test conditions representing realistic automotive impact environments is reported. The test subjects in the program are unembalmed male human cadavers (about 50th percentile) which are suitably instrumented, restrained with 3-point belts, and subjected to test environments at various levels of crash severity. Prior to testing, anthropometric measurements, including X-ray anthropometry, are made on each subject to quantify the subject's geometric characteristics and to locate the test instrumentation with respect to anatomical landmarks. During the test period reported, the surgical techniques were refined, the instrumentation hardware was redesigned and improved, the number of accelerometers was increased, the photographic coverage was improved, and the test protocol was generally refined. A total

of 25 sled tests were conducted during this period. Four cadavers were each subjected to two tests, and a Part 572 dummy with two types of instrumentation was subjected to 17 tests of three severity levels for the purposes of comparison with cadaver response and to compare instrumentation differences. Photographs of dummy and cadaver instrumentation and sled test impacts and X-rays of cadaver injury are provided along with complete test result data.

by Nabih M. Alem; Joseph B. Benson; John W. Melvin  
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich. 48105  
Contract DRDA-74-1748-KB1  
Rept. No. UM-HSRI-76-3; 1976; 473p 9refs  
Report for 1 Sep 1974-31 Aug 1975.  
Availability: General Motors Res. Labs., Biomedical Sciences Dept., Warren, Mich. 48090

HS-018 770

### **HIGHWAY SAFETY NEEDS STUDY. VOL. 1. SUMMARY**

Research Triangle Inst., Res. Triangle Park, N.C.  
1975; 307p 535refs  
Sponsored by the National Hwy. Traffic Safety Administration and the Federal Hwy. Administration, and subcontracted to University of North Carolina Hwy. Safety Res. Center, National Driving Center, Roy Jorgensen Associates, Inc., Business Science Corp., and Wilharbur Communications. For abstract see HS-018 771 and HS-018 772.  
Availability: Reference copy only

HS-018 771

### **HIGHWAY SAFETY NEEDS STUDY. VOL. 2. NATIONAL ESTIMATES AND PROJECTIONS FOR FISCAL 1977-86**

National estimates and projections for highway safety programs in the 10-year period, Fiscal 1977-86, are presented. Study methodology, data documentation, and an overview of the Highway Safety Needs Study (HSNS) are provided and several of the principal alternative national investments and goals which were generated and evaluated in the process of formulating study recommendations are given. Implicit in attaining HSNS recommended national goals are two primary considerations: maintaining the salutary effects on safety caused by lowered speeds and altered driving attitudes associated with the energy crisis, and initiating certain new and expanded countermeasures which have the potential for high payoff in injury/fatality reduction and in accident frequency reduction. The following countermeasures have been found to be effective: the 55 mph speed limit; seat belt usage; motorcycle helmets; energy absorption devices on fixed roadside objects and breakaway sign and lighting supports; and decreasing the time from accident occurrence to injured victim treatment. The total 10-year initial start-up costs of 51 countermeasures (12 injury/fatality reduction types and 39 accident frequency reduction types) identified in the HSNS are estimated to be about \$52 billion nationally if implemented to a uniform standard in the planning period.

Research Triangle Inst., Res. Triangle Park, N.C.  
1975; 184p 1ref  
Sponsored by the National Hwy. Traffic Safety Administration and the Federal Hwy. Administration. Subcontracted to University of North Carolina Hwy. Safety Res. Center, National Driving Center, Roy Jorgensen Associates, Inc.,

Business Science Corp., and Wilharbur Communications. Vols. 1 and 3 are HS-018 770 and HS-018 772.  
Availability: Reference copy only

HS-018 772

### **HIGHWAY SAFETY NEEDS STUDY. VOL. 3. REVIEW OF TRAFFIC ACCIDENT COUNTERMEASURES**

A review of the effectiveness of traffic accident countermeasures currently in use or being tested is presented, and the results of the state-of-the-art study conducted as part of the Highway Safety Needs Study (HSNS) are reported. The state-of-the-art in accident frequency reduction and injury and fatality reduction classified by 13 HSNS target areas is discussed. The target areas are: emergency response systems; driver behavior improvement; young drivers; traffic enforcement and adjudication; bicycle and pedestrian safety; motorcycle safety; roadway safety improvement; roadside hazard elimination; traffic engineering and operations; vehicle safety improvement; program planning, evaluation, and coordination; traffic records systems; and manpower resource development. Each target area is defined in terms of goals, trends, target accident populations and individual countermeasure effectiveness. The results of the study provide necessary input for determining the projected impact of countermeasures proposed by the HSNS as representing the national collective needs of the 50 states, the District of Columbia, and Puerto Rico. These needs were determined through a process of identifying high payoff countermeasures, extrapolating national estimates from state and local sample data on these countermeasures obtained in surveys conducted in 20 states, and developing national projections for each year in the 10 year planning period, Fiscal 1977-86.

Research Triangle Inst., Res. Triangle Park, N.C.  
1975; 307p 535refs  
Sponsored by the National Hwy. Traffic Safety Administration and the Federal Hwy. Administration. Subcontracted to University of North Carolina Hwy. Safety Res. Center, National Driving Center, Roy Jorgensen Associates, Inc., Business Science Corp., and Wilharbur Communications. Vols. 1 and 2 are HS-018 770 and HS-018 771.  
Availability: Reference copy only

HS-018 773

### **MINIMUM REQUIREMENTS FOR THE DESIGN OF A VEHICLE IDENTIFICATION NUMBER SYSTEM FOR PASSENGER CARS. REGULATION VESC-15, APPROVED AUGUST 1975**

Minimum requirements for the design of a vehicle identification number system for passenger cars are presented. The purpose of the regulation is to provide the states with a uniform minimum requirement for the design of a passenger automobile identification number which would provide a unique identification in the interests of highway safety, motor vehicle registration and law enforcement utilization. The Vehicle Equipment Safety Commission regulation, VESC-15, includes: body type; car line; appropriate state official or agency responsible for rules and regulations governing title and registration administration; engine type; field (and fixed length of the field or identification numbers); make; manufacturer; model; model year; passenger car; plant of origin; sequential number; application regulations; promulgated rules and regula-

should be required.

Vehicle Equipment Safety Commission, Suite 908, 1030 15th St., N.W., Washington, D.C. 20005  
Rept. No. VESC-15; 1975 ; 11p  
Availability: Corporate author

HS-018 774

# **MINIMUM REQUIREMENTS FOR THE DESIGN OF A VEHICLE IDENTIFICATION NUMBER SYSTEM FOR NON-MOTIVE POWERED RECREATIONAL VEHICLES. REGULATION VESC-16, APPROVED AUGUST 1975**

Minimum requirements for the design of a vehicle identification number (VIN) system for recreational or utility vehicles, including camping trailers, travel trailers, utility trailers, boat trailers and items of motor vehicle equipment such as slide-in campers and pick-up covers are presented. The Vehicle Equipment Safety Commission regulation, VESC-16, is primarily designed to establish the minimum of identification elements, the codification criteria, and the sequence of identification elements contained in the trailer vehicle identification number system. Definitions are provided for: axle configuration; types of trailers included; field (the set of numbers), and length of field; make; manufacturer; model; model year; plant of origin; year of manufacturer; VIN; application; promulgated rules and regulations; and where and when the VIN should be required.

Vehicle Equipment Safety Commission, Suite 908, 1030 15th St., N.W., Washington, D.C. 20005  
1975 ; 13p  
Availability: Corporate author

HS-018 775

# **AN EVALUATION OF CALIFORNIA'S DRIVERS LICENSING EXAMINATION**

During two, two-week survey periods, data were collected on a total of 8,905 California drivers license applicants. The purpose was to assess the ability of the written and drive tests to screen out accident prone drivers. An additional purpose was to provide descriptive data on the licensing process. Only the written test appeared to have some predictive validity. Correlations between the number of items correctly answered on the applicant's first written test and the subsequent one year driving record variables ranged from .00 to -.10 with eight of the twelve coefficients significant at performance greater than, or equal to, .05. Thus, better performance on the written test tended to be associated with fewer accidents and convictions. For the drive test, the correlations between total score and subsequent driving record ranged from .06 to -.03 with only one of the twelve coefficients significant at greater than, or equal to, .05. Females tended to do better on the written test, worse on the drive test, and have fewer accidents than males. Due to possible biases in the data and to the fact that the above correlations were based only upon those applicants who were licensed within six months subsequent to the survey date, these results should not be viewed as precise. However, they do appear to be consistent with other research. The percentage of applicants licensed within six months of the survey date (the normal expiration date for drivers license application at that time) was 75%, 95% and 91% for first time, out-of-state, and renewal applicants, respectively. Within two

years, 95%, 99% and 96% respectively. Older renewal applicants performed worse on the written and drive tests than younger drivers. There was no difference in the percentage ultimately screened out by the written test for different age groups. The drive test did apparently prevent a larger percentage of older applicants from getting their license renewed.

by Dell R. Dreyer  
State of California Dept. of Motor Vehicles, Res. and Statistics Section  
Rept. No. RR-51 ; 1976 ; 33p 21refs  
Availability: Corporate author

HS-018 776

# **AN EVALUATION OF THE CALIFORNIA DRIVER KNOWLEDGE TEST AND THE UNIVERSITY OF MICHIGAN ITEM POOL. ABSTRACT**

by David W. Carpenter  
California Dept. of Motor Vehicles  
Contract HPR-1(11) B0156  
1976 ; 17p 10refs  
Partially supported through Interagency Agreement No. 13970 with the California Dept. of Transportation, Div. of Highways.  
For abstract see HS-018 777.  
Availability: Corporate author

HS-018 777

# **AN EVALUATION OF THE CALIFORNIA DRIVER KNOWLEDGE TEST AND THE UNIVERSITY OF MICHIGAN ITEM POOL. FINAL REPORT**

A study was conducted to evaluate both the written Division of Motor Vehicles (DMV) drivers licensing test, and a large sample of driver knowledge test items selected from the University of Michigan's Highway Safety Research Institute (HSRI) item pool. Test forms were administered to 48,000 California driver's license applicants. The variables analyzed were subject's sex, age, education, annual mileage, and prior six year driving record in relationship to test form and item scores. New test forms were created and compared to DMV forms. For each test form, the highest test score correlation obtained was with applicant's education, although education had no relationship to accidents or convictions. For all DMV test forms combined, correlations of total scores with driving record variables were all significant, indicating renewal applicants with better prior driving records, obtained higher test scores. Original drivers license applicants scored lower than renewal applicants. HSRI item and test forms were more related to applicants' biographical variables than were DMV items and test forms. Forms created with HSRI items from the initial HSRI item pool screening were less related to driving record than DMV forms. Final forms, created with items that were the most accident related, were neither more nor less related to driving records than DMV forms.

by David W. Carpenter  
Dept. of Motor Vehicles, Res. and Statistics Section, P.O. Box 1828, Sacramento, Ca. 95809  
Contract HPR-PR-1(11) B0156  
Rept. No. CAL-DMV-RSS-75-52 ; 1975 ; 249p 30refs  
Sponsored by the California Div. of Highways under Interagency Agreement 13970. Prepared in cooperation with the Federal Hwy. Administration. Cover date: Apr 1976.  
Availability: Corporate author

HS-018 778

## **FACTORS INFLUENCING THE EFFECTIVENESS OF AUTOMOTIVE REAR LIGHTING SYSTEMS. FINAL REPORT**

The following aspects of automotive rear lighting systems were examined: the effect of various rear lighting configurations on traffic flow characteristics; the value of rear lamp shading; the effects of alcohol and other drugs on color perception; the effects of fog, rain, snow, and sunlight on rear lighting considerations; and the effectiveness of turn signals. Two nighttime studies using three different rear lighting configurations indicated that rear lighting system configurations having separation of function and color coding produced shorter reaction times than the other systems tested. A daytime study conducted primarily to investigate the value of high-mounted signal lamps indicated that these lamps significantly shortened reaction times in multiple car-following situations. The effect of rear lamp shielding was compared with such other variables as lamp intensity, color, background reflectance, and signal configuration under conditions of low and high sun angle. The results indicate that the variable having the most effect on subject response was signal intensity, although shielding of rear signal lamps was of value under a more restricted set of circumstances. A review of the literature concerning the effects of alcohol and other drugs on the perception of color indicated that color perception appears to be relatively unaffected by normal dosages of most common drugs. Data are presented on the incidence of fog, precipitation, snow, and sunlight in various regions of the United States during 1970. These data reflect the incidence of weather conditions which influence the detectability of rear signal lighting signals. A subjective assessment of the effectiveness of flashing signals which go from signal intensity to off rather than from signal intensity to presence intensity indicates that the former configuration would be undesirable because there appears to be little benefit in increased signal effectiveness by such an arrangement and because in the event that the signal filament is burned out, one side of the car would be unmarked when the turn signals are used.

by Paul L. Olson; Craig M. Jorgenson; Samuel P. Sturgis; J. Kirby Thomas; Patricia Domas  
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor, Mich.

Contract UM-7203-C128

Rept. No. UM-HSRI-HF-75-4 ; 1975 ; 106p refs

Sponsored by the Motor Vehicle Manufacturers Assoc., Inc.  
Availability: Motor Vehicle Manufacturers Assoc., Inc., 320 New Center Bldg., Detroit, Mich. 48202

HS-018 779

## **ACCIDENTS OF MOTOR CARRIERS OF PASSENGERS. 1973/74**

Data in this report covers the 1973/74 accidents of motor carriers of passengers (buses), drawn from accident reports filed by motor carriers of passengers operating in interstate or foreign commerce. Reports were filed for those accidents resulting in death, injury or \$2,000 or more property damage. The report begins with a summary section, containing background data on the intercity bus industry and a summary of the accident data for the two years covered in this report. The summary contains information on the number of accidents, fatalities, injuries and property damage by type of operation. The types of operation referred to in this report are

regular, and charter (which also includes special operations.) From 1973 to 1974, reported vehicle mileage increased about 5%. In spite of this, all categories of accident statistics declined in the same time span. In 1973, 148 carriers reported 785 accidents, resulting in 105 fatalities, 2,480 injuries and \$3.0 million in property damage. In 1974, 137 carriers reported 708 accidents, resulting in 77 fatalities, 2,153 injuries and \$2.9 million in property damage. The main body of the report is divided into five sections: highway environment; time and place; the driver; the vehicle; and the accident itself. Each individual section has its own pertinent tables, charts, and graphs, as well as descriptive commentary.

Federal Hwy. Administration, Bureau of Motor Carrier Safety  
1976 ; 90p

Availability: Corporate author

HS-018 780

## **A NEW CONCEPT FOR HEAVY DUTY HIGHWAY TRACTORS**

Prior to World War II, most heavy duty highway trucks and tractors were built as conventionals, that is, with the cab mounted behind the engine. In the late 1940's however, cab-over-engine (COE) types gained acceptance and in the 1950's the tilt cab COE including sleeper cabs was developed in its present form. The new concept seeks to combine the best features of conventionals and tilt cab COEs to develop a superior non-sleeper tractor that makes no compromises for sleeper cab types. This design, known as CONCO, because of the narrower cab, simple design and parts eliminated, comes out lighter than full COEs, offering operators more potential payload. Photographs of the CONCO design are provided.

by John W. Zimmerman, Jr.; Clifford E. Peterson  
International Harvester Co.

Rept. No. SAE-751018 ; 1975 ; 9p

Presented at the Truck Meeting, Philadelphia, Pa., 10-13 Nov 1975.

Availability: SAE

HS-018 781

## **STUDY OF POTENTIAL FOR MOTOR VEHICLE FUEL ECONOMY IMPROVEMENT. AIR QUALITY AND EMISSIONS PANEL REPORT**

The impact of motor vehicle emission reduction on the total emissions or air quality of specific metropolitan areas is discussed. The percent contribution of seven emission source categories to total regional emission of non-methane hydrocarbons and nitric oxides in ten regions and a "composite" region is tabulated. The construction of air quality models, and the calculation of expected emission conditions and changes due to fuel economy measures are discussed. Presentations of mobil source emission limit assumptions, deterioration factors, fractional mileage by vehicle age, and the calculations of emission factor ratios are appended.

Department of Transportation; Environmental Protection Agency

Rept. No. R-3 ; 1975 ; 41p 4refs

Report no. 3 of seven panel reports prepared by a Task Force jointly established by the Department of Transportation and the Environmental Protection Agency.

Availability: Corporate author



HS-018 782

## STUDY OF POTENTIAL FOR MOTOR VEHICLE FUEL ECONOMY IMPROVEMENT. POLICY ASSESSMENT PANEL REPORT

The findings of the Policy Assessment panel of an overall study of the practicability of a fuel economy improvement standard of 20% for new motor vehicles produced in the 1980 time frame are presented. The work of the Policy Assessment Panel focused upon the merits and deficiencies of various implementation strategies and enforcement mechanisms by which fuel economy improvements can be elicited. Definitions of relevant terms and the technological background are given. The nine implementation strategies selected for examination are described generally. The evaluation criteria by which the assessment of the strategies was done are presented, followed by the results of that assessment and the conclusions drawn. The administrative problems inherent in the implementation of any strategy, such as test and certification, labeling and enforcement remedies are reviewed. No strategy emerges as clearly preferable over all the others, each having pronounced strengths and weaknesses. It may be concluded, however, that as a Federal regulatory policy becomes stronger, the certainty of achieving given fuel economy goals will be increased. Appendices provide detailed analyses and comparisons of the nine strategies: voluntary and mandatory fuel economy labeling; production weighted average standards (a common standard, a uniform percentage improvement, or a variable improvement standard); class standards (uniform or variable improvement for each class); and vehicle fuel efficiency taxes (excise tax, and annual fuel efficiency tax).

Department of Transportation; Environmental Protection Agency

Rept. No. R-1 / 1975 ; 91p 12refs

Report no. 1 of seven panel reports prepared by a Task Force jointly established by the Department of Transportation and the Environmental Protection Agency.  
Availability: Corporate author

HS-018 783

## A ROAD FRICTION SURVEY AND STUDY OF SKIDDING ACCIDENTS IN ISRAEL

The basic principles and problems involved in the study of road friction are reviewed. Discussions in foreign publications are reviewed and present work done in Israel, particularly road friction surveys conducted in 1972 and 1973 and a British Portable Tester-Mu-meter correlation study, are covered. A tentative skid-resistance guideline for Israel is also suggested. Topics of discussion include: the principles of pavement friction (the mechanism of rubber friction and tire friction and factors affecting pavement friction); factors affecting the demand for friction (human, road, vehicle, and environmental factors); and methods of measuring friction and texture of pavements (friction, texture, and wear resistance measurements).

by Tsvi Hyman; Shalom Hakkert

Israel Ministry of Transport, Road Safety Centre; Technion Res. and Devel. Foundation, Ltd., Israel  
Rept. No. Wp-73/9 ; 1973 ; 84p 10refs  
Availability: Israel Ministry of Transportation, Road Safety Centre

HS-018 784

## A NEW CONCEPT IN CAB-OVER-ENGINE TRUCK DESIGN

In 1973, an experimental cab-over-engine class eight highway vehicle was designed and built by Kenworth Truck Company to evaluate market impact generated by a unique looking vehicle. Various design aspects as related to driver comfort and associated component development are presented. To provide separate sleeping accommodations for two people, total cab height from current production models was increased by 22 inches. This increase was also used to develop a roof contour with esthetic value and to moderate air flow characteristics to the fullest extent possible. Other innovations included an experimental heater-air conditioner system on a prototype rear chassis suspension and were installed and evaluated during the life of the project. The successful completion of this highly experimental undertaking required the efforts and cooperation of numerous designers, test personnel, vendor organizations, and vehicle users. Two road tests were conducted. The first took the truck through 11 Western states during a period of three months and approximately 23,000 miles of interstate travel. Payloads ranged from refrigerated vans full of frozen foods to flat-beds carrying steel or lumber. Thorough inspection upon completion of the interstate road test revealed no significant problems in the design or construction of the cab structure. The second test involved carrying general freight and heavy equipment across the north slope of Alaska. Approximately 19,000 miles were logged. From the results of the inspection, it was generally agreed that the truck design and construction proved quite satisfactory. Photographs of the new design components are provided.

by Wayne K. Simons

Kenworth Truck Co.

Rept. No. SAE-751017 / 1975 ; 11p

Presented at the Truck Meeting, Philadelphia, Pa., 10-13 Nov 1975. Prepared in cooperation with Creager Trucking Co. Inc., and Lynden Transport Inc.

Availability: SAE

HS-018 785

## ROAD SAFETY IN ISRAEL--1972

The traffic safety situation in Israel is surveyed and compared in some detail to that in the United States. Major differences in the pattern of fatalities exist. In the U.S., for instance, pedestrian fatalities accounted for only 17% of the total. In Israel, pedestrians accounted for 50% of all the fatalities. Although travel in both countries seems equally split between urban and rural roads, in the U.S. 70% of all fatalities occur on rural roads, compared to about 45% in Israel. A projection of the number of traffic fatalities in Israel in the mid-1980's shows that at that time, population might reach 4 million, number of motor vehicles will reach one million, and number of fatalities per year may be as high as 1,400. On Israel's scale, this is equivalent to about 70,000 road fatalities in the United States today, with only half the number of motor vehicles. These figures call for immediate drastic attempts to reduce the number of road accidents. A number of possible road safety actions are considered, and it is concluded that large road investments are at present most likely to produce proven short-term and long-term accident savings. A number of road improvements studied showed reductions of 20-50% in the number of accidents. A brief statement of road safety research projects carried out at the Technion Research and

Development Foundation of Israel and photographs of various road designs and configurations are presented.

by Moshe Livneh; A. Shalom Hakker  
Israel Ministry of Transport, Road Safety Centre; Technion  
Res. and Devel. Foundation, Ltd., Israel  
Rept. No. Pub-72/3 : 1972 ; 39p 13refs  
Availability: Israel Ministry of Transport, Road Safety Centre

HS-018 786

## **DRINKING-DRIVING IN THE PROVINCE OF ONTARIO. A REVIEW OF "CHECK STOP" AND THE 24-HOUR LICENCE SUSPENSION**

The Alberta, Canada, program of 24 hour driving license suspension imposed at the roadside to drivers under suspicion of having consumed enough alcohol to impair their mental or physical abilities and the Check Stop Program, a selective police roadblock used to discover and discourage drinking and driving, are explained and evaluated. The methodology, background, legislation, and acceptance of these programs are discussed. It is concluded that both programs could be effective drinking-driving countermeasures and modifications are offered for improving them. The additional need for good public education programs to accompany these other programs is emphasized. The first annual report for the Alberta Check Stop Program is appended.

by Howard F. Morton; W. Bolton; David Hieatt; Tony Cunliffe  
Ministry of the Attorney General; Ministry of the Solicitor General; Ministry of Transportation and Communications  
1975 ; 77p 11refs  
Availability: Ministry of Government Services, Publications Center, 3B7 MacDonald Block, Queens Park, Toronto, Ont. M7A 1N5, Canada, \$5.00 prepaid to Treasurer of Ontario

HS-018 787

## **PASSENGER PROTECTION IN SIDE IMPACTS**

Vehicle passenger protection in side impacts at an angle and blunt perpendicular side impacts is discussed. About half of all side impacts are angular. It was found that the best reduction of deformation could be achieved by ensuring that no link of the side structure failed but the total side act as a guardrail. Reinforcements of lock and hinge, and door and door beltline are discussed. For the blunt perpendicular side impact, where deflection of the bullet car's path for energy dissipation is not possible, solutions are more difficult to find. The inertia forces of the occupants caused by the acceleration of their bodies when being pushed sideways after contact with the doors, or contact among themselves, cause the injuries. Padded door trim, armrests, and side supports on seats can attenuate the peak loads and safety belts can alter the occupant collision trajectories beneficially. The value of injury numbers (Head Injury Criteria and Severity Index) calculated from present dummies is considered. The discussion is meant to be presented with slides.

General Motors Corp., Environmental Activities Staff,  
Warren, Mich. 48090  
n.d. ; 13p  
Availability: Corporate author

HS-018 788

## **INERTIA BRAKE DYNAMOMETER TESTING TECHNIQUES FOR FMVSS 121**

Federal Motor Vehicle Safety Standard 121 has focused attention on the inertia dynamometer as a friction material and brake component test instrument. The National Highway Traffic Safety Administration has also expressed interest in using the inertia type dynamometer as an evaluating tool for a friction material standard primarily aimed at the replacement market. With the emphasis being placed on inertia dynamometers, the friction material manufacturers have responded to the needs of the braking industry by expanding dynamometer test capabilities. The need for standardization in inertia brake dynamometer techniques and the basic principles for setting up an "S" cam air brake for evaluation under laboratory conditions are discussed. Specific brake conditions show the need for standardization of brake set-up for obtaining the optimum output from a brake and friction material combination. A major portion of the increased cost had to be absorbed by friction material manufacturers to fulfill the needs of the vehicle, axle, and brake manufacturers. The techniques presented, if used by the laboratories in this type of testing, will improve correlation of test information and will be of benefit to the braking industry.

by Donald E. Steis  
Abex Corp., Res. Center  
Rept. No. SAE-751010 : 1975 ; 10p  
Presented at the Truck Meeting, Philadelphia, Pa., 10-13 Nov 1975  
Availability: SAE

HS-018 789

## **DRIVING WHILE DISQUALIFIED**

Research was conducted to determine the differences between people who drive while disqualified from driving and disqualified drivers who do not drive again in regard to: length of disqualification originally imposed and outstanding at the time of the disqualified driving; offenses for which originally disqualified; history of criminal offenses and penalties imposed; history of traffic offenses and penalties imposed; age; occupation and educational level; type of vehicle used; and driver's need of his vehicle for employment. Attempts were also made to establish the circumstances in which the offense of disqualified driving was detected and the range of penalties imposed by courts for the offenses of driving while disqualified. A sample of 305 persons convicted of driving while disqualified and 215 disqualified drivers without such a conviction and information regarding these drivers were obtained from records at New Scotland Yard in London, England. It is concluded that disqualification is best used as a means of keeping drivers who are a potential danger off the road or of punishing drivers who do drive while disqualified. It is least useful as a penalty for drivers whose abilities are not in question.

by Sue Kriefman  
Home Office Res. Unit  
Rept. No. HORS-27 : 1975 ; 136p 16refs  
Availability: Pendragon House Inc., 2595 E. Bayshore Rd., Palo Alto, Ca. 94303

HS-018 790

# **THE INTER-RELATED PROBLEMS OF AN ACCIDENT SERVICE AND THE ACCIDENT AND EMERGENCY DEPARTMENT**

The problems of an accident service, the organization of medical personnel and facilities delivering treatment to accident injury patients, and an accident and injury department, basically a casualty department are discussed. The following topics are considered: the number of specialties involved; the amount of trauma within each specialty; minor and major injuries; the reception, resuscitation and sorting of severe accidents; grouping patients by specialty and diagnosis; supervision in the accident and emergency department; and nomenclature.

by W. H. Rutherford

Publ: Injury: The British Journal of Accident Surgery v7 n2  
p96-100 (1975)

1975; 2refs

Availability: See publication; W. H. Rutherford, Casualty Dept., Royal Victoria Hosp., Belfast, BT12 6BA

HS-018 791

# **PREARREST BEHAVIOR OF PERSONS CONVICTED OF DRIVING WHILE INTOXICATED**

A study was undertaken to determine the prearrest behavior of persons convicted of driving while intoxicated. The study was drawn from the files of persons convicted of driving while intoxicated (DWI) in the El Cajon, California courts. During the study, the convicted persons were required to submit a narrative report of their activities 12 hours prior to their arrest. It was found that one half of the persons arrested for DWI had been drinking with friends, relatives or spouses prior to the arrest, but few reported that any attempt had been made to stop them from driving. Measures designed to reduce the incidence of drunken driving are discussed, including limiting the amount of drinking that can be done in a licensed establishment.

by Richard D. Yoder

Publ: Journal of Studies on Alcohol v36 n11 p1573-7 (1975)

1975; 5refs

Availability: See publication

HS-018 792

# **EMS: THE GOOD AND THE BAD**

Some of the history, the problems, advantages, and applications of the five components (detection, notification, dispatch, treatment, and transfer) of an emergency medical services (EMS) system are discussed. The interrelations of the components, the importance of the treatment of victims at the scene rather than ambulance speed, and the possibilities for helicopter use are emphasized. Most EMS programs continue to suffer from dangerous inadequacies in equipment, procedures and personnel. More community leaders and government officials must be motivated to launch new programs and improve existing ones.

by Timothy R. Letzкус

Publ: Highway User Quarterly p18-24 (Spring 1976)

1976

Availability: See publication

HS-018 793

# **MODERN EUROPEAN HIGHWAY TRUCK DESIGN--THE BEDFORD TM**

The design and operation of highway trucks in Europe is subject to legislation which is more detailed and restrictive than in the United States. The operating environment and consequently the market preferences frequently differ from those in North America. Important European legislation and marketing factors affect truck design, as is seen in the case of heavy trucks. A new range of heavy duty trucks, therefore, has been designed primarily for operation in Europe. These include the Bedford from Vauxhall with a range of diesel engines up to 150 horsepower, rear axles up to 11 tons, front axles to 6.5 tons and a four-speed synchronized transmission. The total model range comprises over 40 models, using three cab styles and three base engines. Many Bedford truck features are similar to modern North American trucks. For instance, the cab design was basically derived to satisfy the requirements of a range of vehicles from a cost-competitive medium to heavy straight truck, to a premium maximum weight tractor with sleeping facilities. Other similarities are seen in the variable rate taperleaf suspension. European legislation relating to trucks is varied and complex. The size, weight, noise level and performance of heavy duty trucks are all subject to differing regulations. Although efforts are being made to achieve a common set of regulations, it is still necessary for the vehicle manufacturers to offer special options to meet specific requirements.

by A. J. McKay

General Motors Corp., General Motors Overseas Operations Div.

Rept. No. SAE-751019; 1975; 13p

Presented at the Truck Meeting, Philadelphia, Pa., 10-13 Nov 1975.

Availability: SAE

HS-018 794

# **HIGHWAY TRAFFIC NOISE PREDICTION METHODS. PROCEEDINGS OF A WORK SHOP HELD SEPTEMBER 23-24, 1975, IN WASHINGTON, D.C.**

Presented are the proceedings of a workshop conducted to: identify and prioritize major problem areas and deficiencies relating to highway traffic noise prediction; explore and possibly outline future projects for resolving the problems and deficiencies; and lay the foundation for a single, universally accepted highway traffic noise prediction procedure. The following topics are discussed: the importance of noise prediction models as a keystone in applying noise standards; an evaluation of two noise prediction methods; experimental data supporting a design guide for highway noise prediction and control; a history of highway noise prediction methods; differences between the design guide and two authorized noise prediction methods; how traffic noise models are used, how well they work, and why; the application and findings in North Carolina of the TSC noise prediction methodology, originally issued by the Federal Highway Administration; Minnesota's experience with traffic noise prediction; an Ontario, Canada, highway noise prediction method; an analysis of approved and recently developed prediction methods; and future projected

vehicle source noise emission levels for use in highway traffic noise prediction calculations.

Publ: Transportation Research Circular n175 pl-77 (Jan 1976) 1976; 77p  
Sponsored by the Transportation Res. Board's Committee on Transportation-Related Noise.  
Availability: Transportation Res. Board, National Res. Council, 2101 Constitution Ave., Washington, D.C. 20418

HS-018 795

### **EFFECTS OF THE NATIONAL 55 MPH SPEED LIMIT. INTERIM REPORT. VOL. 1. NONSAFETY ASPECTS**

The effects of reducing the national highway speed limit to 55 mph are examined. Nonsafety factors are identified and work plans for studying these factors are presented. The factors identified are grouped into five general areas: effect on road maintenance, vehicle sales and maintenance, noise and vehicle emissions; effects on commercial bus and trucking industries; enforcement of and compliance with the 55 mph speed limit; economic consequences of changes in the number of accidents; and aspects of travel and tourism.

by Robert F. Heckard; Frank A. Haight; John A. Pachuta  
Pennsylvania State Univ., Pennsylvania Transportation Inst., Res. Bldg. B, University Park, Pa. 16802  
Contract DOT-FH-11-8597  
Rept. No. PTI-7518 / 1975 / 24p  
Rept. for 7 Feb-7 Aug 1975.  
Availability: NTIS

HS-018 796

### **EFFECTS OF THE NATIONAL 55 MPH SPEED LIMIT. INTERIM REPORT. VOL. 2. SAFETY ASPECTS. REV. ED.**

The effects on traffic safety of reducing the maximum national highway speed limit to 55 mph nationwide are examined. Monthly fatal accidents, fatalities, injury accidents, and injuries in North Carolina, Colorado, Texas and Washington are examined using a statistical time series intervention model. Interventions included in the model are the reduced speed limit and the fuel shortage. Several significant decreases in fatality, accident, and injury rates (per million vehicle miles) are attributed to the reduced speed limit, but the results should be regarded as tentative until a more extensive analysis is completed. Complete data tables and illustrative graphs are provided.

by R. F. Heckard; J. J. Wiorowski; J. A. Pachuta; D. L. Wahrenberger; F. A. Haight  
Pennsylvania State Univ., Pennsylvania Transportation Inst., Res. Bldg. B, University Park, Pa. 16802  
Contract DOT-FH-11-8597  
Rept. No. PTI-7519 / 1975 / 85p 15refs  
Rept. for 7 Feb-7 Aug 1975.  
Availability: NTIS

HS-018 797

### **FUEL ECONOMY IMPROVEMENTS THROUGH EMISSIONS INSPECTION/MAINTENANCE**

A study was carried out that permitted determination of the impact of annual emissions inspection/maintenance on fuel economy. To evaluate the effect of malfunctions on fuel economy, a group of 34 cars was selected that provided a sampling of several variables that would be easy to identify in larger groups of cars: weight; year of manufacture; make; number of cylinders; and engine size. Each car was initially tuned up and run through a sequence of three dynamometer tests. One malfunction at a time was then introduced and tests repeated. Interaction effects were studied on a subset of the cars by testing combinations of malfunctions. Quantification of the effects of individual engine malfunctions on fuel economy and application of the results statistically to a fleet of 105 cars indicated that if 50% of a car population was rejected for high emissions and tuned up, the estimated gain in fuel economy among the rejected cars would be 13%. The testing approach used permitted calculation of fuel economy effects when distributions of some car characteristics, driving patterns, and engine malfunctions are known, and the results apply only to pre-1975 cars. It was found that repairs carried out to correct only emissions should produce about 75% of the fuel economy benefit achieved by a complete tune-up. When deterioration between annual inspections was considered and 50% of the car population was rejected for high emissions, the net gain in fuel economy among the rejected cars was about 7.5%, which was significant at the 95% confidence level. The net gain in fuel economy among rejected cars was not statistically significant at rejection rates lower than 30%. When the effect of repairing the 50% highest emitters was spread over the total car population, the estimated 2% fuel economy benefit was not significant.

by J. Panzer  
Exxon Res. and Engineering Co.  
Rept. No. SAE-760003 / 1976 / 10p 13refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976.  
Availability: SAE

HS-018 798

### **AUTOMOTIVE MIRROR SIZE REQUIREMENTS BASED ON FIELD OF VIEW CONSIDERATIONS**

A two mirror computer model of automotive rear vision was developed based on a minimum field of view approach. A system of conventions for the rear vision target, minimum field of view, head positioning, mirror orientation, and head rotation was used to establish parameters for the computer results in terms of the position of the center of the inside mirror and the left outside mirror. General results for the minimum horizontal mirror size and driver head turn required to see the target are presented. Superimposition of several existing automotive models on the computer analysis results indicates that some redesign would be necessary for certain automotive models to meet a specific field of view requirement with a reasonably sized mirror and that, in any case, a somewhat different approach to rear vision design would be necessary. A sensitivity analysis was performed to evaluate the sensitivity of the mirror size to various parameters in the

dependent on the transverse eye-mirror distance.  
by James W. Seeser  
Hope College  
Rept. No. SAE-760005 ; 1976 ; 8p 4refs  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 23-27 Feb 1976.  
Availability: SAE

HS-018 799

## **EVALUATION OF A NEW AUTOMOTIVE PLANE AND CONVEX MIRROR SYSTEM BY GOVERNMENT DRIVERS**

An on-the-road study was conducted of new mirror systems consisting of larger inside and left side plane mirrors and a convex mirror on the right fender. About 150 Federal drivers evaluated this experimental mirror system on a test fleet of 23 passenger cars located at four sites over a six month period beginning in September 1974. The test cars were used either as dispatch cars that could be used by any Federal employee from a common pool of vehicles or by assignment to an individual or a small working unit. In each case, the driver was asked to complete a questionnaire to evaluate reaction to the use of the new convex mirror system. The questionnaires contained questions about the driver; questions about the trip, the weather conditions, and the vehicle assignment; and questions about the driver's reaction to the use of the convex mirror installation. An analysis of the questionnaire responses indicates that the drivers generally reacted favorably to this experimental mirror system. When compared to previous mirror systems tested, the drivers rated the new plane and convex mirror best; the periscope system second; a system consisting of two convex mirrors, one mounted on each fender, and a standard plane inside mirror third; and a system consisting of an original equipment outside plane mirror on the driver's side, a slightly larger inside mirror, and a convex mirror on the right fender last. All of the rearview mirror systems tested were rated lower at night than during the day and much lower during adverse weather. All four systems were rated better for freeway use than for city use and better for city use than for rural use. In all cases, the evaluators were most impressed by the reduction in blind areas due to the improved rearward fields-of-view.

by Charles H. Kaehn  
National Hwy. Traffic Safety Administration  
Rept. No. SAE-760006 ; 1976 ; 12p 6refs  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 23-27 Feb 1976.  
Availability: SAE

HS-018 800

## **HEAT TRANSFER IN A PISTON OF A FOUR STROKE DIESEL ENGINE**

A design tool has been developed for analyzing heat flow rates through the pistons of a four-stroke diesel engine. Test were conducted on a Petter PIJW engine using a range of conditions including different fuel inputs, speeds, boost pressures, and intake temperatures. The steady-state piston temperatures were determined by measuring the change in hardness of stainless steel inserts. With the aid of an electrolytic tank analogue, these data were used to provide isothermal plots of the PIJW

engine. The analyses were performed using a dimensional relaxation program giving master temperature and heat flux patterns that are valid for all engine conditions. The temperature distribution on the surface of the piston was found to be axially symmetric. The heat transfer through the bowl was shown to be higher than that through the crown. The calculated mean heat transfer rates through the piston tend to support the trends suggested by Annand's semi-analytical correlation.

by M. Ramchandani; N. D. Whitehouse  
Applied Technology Assoc., Inc.; University of Manchester,  
Inst. of Science and Technology, United Kingdom  
Rept. No. SAE-760007 ; 1976 ; 11p 16 refs  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 23-27 Feb 1976.  
Availability: SAE

HS-018 801

## **ANALYSIS OF PISTON RING LUBRICATION**

A method has been developed for computation of the oil film thickness between the piston ring and cylinder liner of an internal combustion engine. The effect of a lateral force due to friction between piston ring and ring groove has been considered a significant factor in the lubrication analysis of a piston ring. The effect is a circumferential variation of oil film thickness and pressure, which has been studied by considering a three-dimensional form of Reynold's equation. Various ring face profiles and the tipping of the ring about the piston axis are considered in the analysis. A viable algorithmic scheme for calculating oil film thickness and friction between the piston ring and cylinder liner is presented and discussed. The solution of the lubrication equation is achieved through the use of a finite difference approximation. It is suggested that this scheme should prove useful for simulating piston and piston ring behavior.

by Pranab K. Das  
John Deere Product Engineering Center  
Rept. No. SAE-760008 ; 1976 ; 10p 9refs  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 23-27 Feb 1976.  
Availability: SAE

HS-018 802

## **PLAIN BEARINGS FOR THE HIGH SPEED DIESEL ENGINE**

The outlook forecast for truck diesel engines indicates that higher specific loadings will occur on the connecting rod and main journal bearings in the future. Bearing materials are designed around the parameters of load carrying capacity, strength at high temperatures, co-efficient of friction, dirt embeddability, corrosion resistance, and ability to accept misalignment. A variety of materials are currently used for bearings and bearing overlays. The use of plastic lined bearings could be a possibility for the lightly loaded diesel engine applications, and such bearings are currently being developed by some manufacturers. New methods of producing in strip form a bearing material complete with intermediate layer and overlay ready for the final operation of forming the semi-cylindrical bearings are being developed. Some means of evaluating the wear and load carrying capacity of bearings is needed. Specially designed rigs provide purely comparative data which can be used to select the most promising material

for engine test bed running, but the tests cannot be used to evaluate actual service performance. Trends in the manufacture of trimetal bearings are being directed at increased production and reduced costs by elimination of machining operations necessitating considerable physical movement of vast numbers of pieces and elimination of reclamation or loss of high cost materials arising from this machining. The expected higher specific loadings will necessitate consideration of design changes in main bearings, connecting rod big-end bearings, connecting rods, and crankpin hole position. Some aspects of the problems involved and possible alternatives with regard to these design considerations are presented.

by C. H. Davison  
Vandervell Products, Ltd., United Kingdom  
Rept. No. SAE-760009; 1976; 10p 4refs  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 23-27 Feb 1976.  
Availability: SAE

HS-018 803

### THE APPLICATION OF HIGH STRENGTH STEEL TO BUMPER REINFORCEMENTS

The steps taken by the Ford Motor Company to meet the Federal Motor Vehicle Safety Standards No. 215 for 1973 and for 1974 are outlined. These standards required that vehicles manufactured after August 1972 be able to withstand a fixed barrier crash at 5 mph for the front end and 2.5 mph for the rear with no damage to headlights or taillights, hoods, trunks, doors, or fuel, cooling, and exhaust systems. The 1974 requirements included pendulum tests as well as barrier tests and increased the rear test speed to 5 mph. In addition, propulsion, suspension, steering, and braking mechanisms were to be unaffected. To meet the 1973 standards, energy absorption units were used to absorb and reduce the shock transmitted to the vehicle and reinforcements were needed behind the bumper face bars. The front bumper reinforcement designs consisted of two Z-shaped sections spot welded together and the rear bumper reinforcement design consisted of one Z-shaped section, all made of regular low carbon steel. To meet the 1974 requirements, the design of the reinforcements was changed to a more rigid closed box design constructed of high strength, low alloy (HSLA) steel. The HSLA steel selected for the bumper reinforcements was SAE 980 XK, with sulfide shape control and .089 inches minimum thickness. Proper design of the parts to be made of HSLA, good processing and die design, and a choice of die materials that would take the stresses involved resulted in a minimum of production process problems for the bumper reinforcement program at the Ford Motor Company. Once an adequate supply of the HSLA steel was established, material cost reductions were achieved by engineering retesting to lower strength HSLA and proper production testing of lower cost grades of 50 ksi instead of the 0 ksi HSLA steel.

by Victor A. Kortesoja  
Ford Motor Co., Metal Stamping Div.  
Rept. No. SAE-760010; 1976; 6p  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 23-27 Feb 1976.  
Availability: SAE

HS-018 804

### TOOLING CONSIDERATIONS IN THE USE OF HIGH STRENGTH LOW ALLOY STEEL

Some new and unfamiliar techniques and rules established in the manufacture of sheet metal stampings made from high strength low alloy (HSLA) steel with yield strengths up to 80,000 pounds per square inch are discussed. The example used to demonstrate these techniques and rules is the 1976 "B" Body Front Bumper Reinforcement, which embodies a large number of the conditions encountered in the manufacture of a sheet metal stamping from 980 material and is one of the largest and most complicated sheet metal stampings manufactured from 980 steel. Drawing parts from the 980 steel material requires special considerations for its maximum elongation characteristics and the fact that it will not sideslip in the draw operation as much as the conventional 1010 material. Part design changes in the draw operations were also necessitated by the switch to 980 material. Trimming operation considerations are similar to conventional practices except that an additional 5% cutting steel die clearance is required with the 980 material and additional die steel shear allowance is recommended to reduce shock and press tonnage. The forming and flanging reactions from 980 material cause the greatest single difference in tooling considerations due to the spring-back characteristics of the 980 material, requiring more overbending and tonnage to set its shape than when 1010 steel is used. The tonnage required for piercing parts from 980 steel is almost double that required with 1010 steel. Several die lubrication approaches have been used to produce quality stampings and satisfy the die maintenance problems.

by R. J. Marks  
General Motors Corp., Oldsmobile Div.  
Rept. No. SAE-760011; 1976; 6p  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 23-27 Feb 1976.  
Availability: SAE

HS-018 805

### WEIGHT REDUCTION OF AUTOMOBILE BUMPER SYSTEMS

Weight reductions in automobile bumper systems were achieved by means of a three phase program: reduction of the bumper reinforcement gauge by use of work hardening renitrogenized steel; reduction of the bumper face bar gauge by use of high formability, high yield strength, inclusion shape control steel; and design changes to minimize or eliminate bumper reinforcements. The weight reductions (up to 36 pounds per vehicle) were achieved without reducing the impact strength of the bumper systems.

by John I. Kary  
General Motors Corp., Chevrolet Motor Div.  
Rept. No. SAE-760012; 1976; 7p  
Presented at the Automotive Engineering Congress and  
Exposition, Detroit, Mich., 23-27 Feb 1976.  
Availability: SAE

## THE DEVELOPMENT AND PERFORMANCE OF A SELF-CONTAINED SOLID STATE DIGITAL CRASH RECORDED FOR ANTHROPOMORPHIC DUMMIES

A solid state, low power, self-contained digital crash recorder was developed and installed in the Part 572 crash test dummy for capturing and storing the crash severity-time event. The crash recorder is capable of recording (upon internal triggering command) the dummy's response in 10 separate data channels. The recorder's performance was evaluated in laboratory and vehicle tests consisting of simulated and real rigid barrier collisions in the forward impact mode and moving barrier collisions in side impacts. The recorder was found to be suitable for capturing and storing high quality crash data compatible with currently used hardware data acquisition techniques.

by Stanley H. Backaitis; Edwin M. Trout; Randolph J. Wolf  
National Hwy. Traffic Safety Administration Federal Aviation Administration; Kaman Sciences Corp.  
Rept. No. SAE760013; 1976; 34 refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976. Sponsored by the National Hwy. Traffic Safety Administration. Prepared in cooperation with Robert Carter, James Hofferberth, Joseph Clark, Richard Chandler, Donald Bryce and Egbert Enserink.  
Availability: SAE

HS-018 807

## POWER AND BODILY INJURY

An attempt is made to establish a correlation between bodily injury and the rate at which energy is transferred to the body. Two head impacts were analyzed to demonstrate the procedures, from eleven head impact test results. The method involved the fundamental laws of mechanics and only the power levels were established empirically. Equations were developed that related power to the absolute values of acceleration and the product of momentum and jerk. From the derived mathematical expressions, a procedure of analyzing experimental data was drawn. An appendix contains the computer program for performing the analysis. It was found that the probability of bodily injury in a crash appeared predictable based on the rate at which energy was transferred to the body. It was further found that the fundamental equations of mechanics can be derived that relate acceleration and jerk for the acceleration-time pulse. The energy rates associated with all possible acceleration pulse shapes can be analyzed in a routine manner. The value used for calculating the severity index and the head injury criterion was needed because only the absolute value of acceleration was used for the empirical relationship relating bodily injury to acceleration and time. Momentum and jerk were not included here. An approximate constant power process represented the optimum method for adding energy to a body. The maximum power level varied for different parts of the body.

by Francis A. DiLorenzo  
National Hwy. Traffic Safety Administration  
Rept. No. SAE-760014; 1976; 12p 11 refs  
Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976.  
Availability: SAE

## SENSORS FOR ELECTRONIC SYSTEMS

A precision engine air input measuring meter has been developed by the Ford Motor Company. This vortex shedding principle meter uses both temperature and pressure sensors to normalize incoming air calculations in order to constantly report at a high electronic data rate the mass air inflow to the engine. A means for accurately measuring engine intake air is a necessary component of any engine control system designed to improve fuel economy and lower the emission output of the engine. The National Semiconductor Corporation has developed a simple mechanical device which allows the use of a reasonably specified pressure transducer for flow and total volume metering. One approach to meeting statutory automotive exhaust emission levels is through the use of a closed-loop engine control system which utilizes developmental three-way catalytic converters and a zirconia oxygen sensor. The sensor provides a feedback signal for stoichiometric air-fuel ratio control of the engine. Work conducted by FloScan Instrument Company, Inc., indicates that turbine transducers will be able to meet the main requirements for onboard automotive fuel flow sensors at a competitive cost. A new wheel velocity sensor developed by the Licon Division of Illinois Tool Works, Inc., represents an application of ferrite core/magnet technology. General Motors Corporation has developed a versatile circuit which converts changes in physical parameters of an automobile engine into a proportional pulse width modulated digital signal which can be used as input to microprocessors and other digital control and diagnostic systems. Massachusetts Institute of Technology has developed an opto-electronic method for the continuous on-board measurement of the output torque from an engine for the purpose of providing a control signal. A new type of frequency output pressure sensor has been devised which utilizes a novel application of Surface Acoustic Wave technology and which can be easily interfaced to digital automotive electronic control systems. All of these electronic system sensors are discussed and illustrated. Measurements of the temperature sensitivity of the zirconia oxygen sensor used to give an electrical voltage output indicative of engine fuel-air ratio over a wide range of operating conditions are also discussed.

Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pa. 15096  
Rept. No. SAE-SP-404; 1976; 64p refs  
Papers presented at the SAE Automotive Engineering Congress and Exposition, Detroit, Mich., 23-27 Feb 1976.  
Availability: SAE

HS-018 809

## EMERGENCY MEDICAL SERVICES SYSTEMS. PROGRAM GUIDELINES. REV. ED.

The Emergency Medical Services Systems (EMSS) Act of 1973 is designed to provide assistance and encouragement for the development of comprehensive emergency medical services systems throughout the United States (U.S.) and thereby improve the quality of patient care and reduce morbidity and mortality. Program guidelines have been developed to help applicants understand the legislation, regulations, guidelines, and related administrative procedures. The grant process is described from application procedures through grant administration. Potential applicants may use the guidelines to determine their eligibility and the extent of funding limitations. Mandatory requirements for a successful application and

guidance on the EMSS program objectives and philosophy are presented. The criteria and scores by which projects are evaluated are outlined. Evaluation factors are also presented to provide additional guidance on possible in depth detail for inclusion in a grant application. The process for funding of applications, the manner of funds disbursement, the specific and general reporting requirements, and the grant administration responsibilities of the grantee are delineated. Grants may be awarded to states, units of general local government, public entities administering a compact or other regional arrangement, or any other public entity and non-profit private entity for the purposes of feasibility studies and planning, establishment and initial operation of EMSS programs, or expansion and improvement of existing programs. A copy of pertinent rules and regulations is included.

Health Services Administration, Div. of Emergency Medical Services, P.O. Box 911, Rockville, Md. 20852  
Rept. No. DHEW-(HSA)-75-2013 ; 1975 ; 64p  
Availability: GPO; Regional Health Administrator, P.O. Box 13716, Philadelphia, Pa. 19101

HS-018 811

### TRAFFIC SPEED TRENDS REPORT, 1975

Tables are presented summarizing data resulting from speed studies conducted in 1974 by 41 states. The data were obtained from studies conducted primarily during the spring, summer and fall seasons after the national speed limit of 55 mph went into effect. The information was collected on level, straight sections of main rural roads and on urban streets during off-peak periods of traffic. As shown in the report, there was a major decrease in speeds during 1974, with the average speed for all free-moving vehicles on main rural roads being 5 mph less than the previous year. Data indicates that 50% or more of the free-moving vehicles on straight open sections of main rural roads exceeded 55 mph in the majority of states; however, only 21% of the vehicles exceeded 60 mph as compared to 50% in 1973, and the percent of vehicles exceeding 65 mph decreased from 31% to only 6%. Speeds in the central and western regions of the United States averaged about 2 mph faster than speeds in the eastern region. Previously speeds in the central and western region averaged about 5 mph faster than speeds in the east. During 1974, free-flowing speeds on completed sections of the Interstate System averaged 57.6 mph for all vehicles, which was 7.4 mph slower than in 1973. The percent of vehicles exceeding 55 mph decreased from 89% in 1973 to 65% in 1974, and the percent exceeding 60 mph decreased from 72% to 26%.

Federal Hwy. Administration, Washington, D.C. 20590  
Publ: FHWA Bulletin p1-8 (26 Mar 1975)  
1975 ; 9p  
Availability: See publication

HS-018 812

### TRAFFIC SPEED TRENDS REPORT, 1976

Tables are presented which summarize data collected from 29 states during 1975 indicating the traffic speed trends for the year. The results of the studies generally indicate that free-flow vehicle speeds in 1975 remained at about the same level as in 1974. Free-flow vehicle speeds in 1974 and 1975, however, were considerably lower than those of 1973. The studies were conducted on level, straight sections of main rural roads

and on urban streets during off-peak periods of the day when traffic densities were low and drivers traditionally traveled at their desired speeds. The average speed for all free-flowing vehicles on main rural roads for 1975 was 55.8 mph as compared to 55.3 mph in 1974 and 60.3 mph in 1973. The average 1975 speed is based on 56.2 mph for passenger cars, 54.8 mph for trucks, and 55.4 mph for buses. In addition, the percentages of vehicles exceeding speeds of 55, 60 and 65 mph on main rural roads in 1975 were 55%, 21% and 6% respectively. Corresponding percentages in 1974 were 51%, 21% and 6%, and 70%, 50% and 31% in 1973.

Federal Hwy. Administration, Washington, D.C. 20590  
Publ: FHWA Bulletin p1-12 (19 Mar 1976)  
1976 ; 13p  
Availability: See publication

HS-018 814

### THE EFFECT OF BLURRED VISION ON THE CONTRAST SENSITIVITY FUNCTION

A study was made on the effect of blurred vision on the contrast sensitivity function. A standard relative contrast sensitivity function of luminance has been previously defined and the effects of several modifying factors have been described. One modifying factor which has not been considered previously is the effect of blurring the retinal image as the result of ocular defocus. Ocular defocus is common in unselected work populations since refractive errors have a high incidence and are not always fully corrected by spectacles. It is known that ocular defocus causes a substantial increase in contrast threshold. Contrast threshold functions were measured for five observers whose vision was defocused by means of positive lenses. Measurements were made for background luminances ranging from 0.04 to 293 candela per square meter (cd/m<sup>2</sup>). The results show that a modest amount of defocus (0.75 dioptres) increases contrast thresholds by a factor of 2 and that, for greater amounts of defocus, threshold contrast is increased by factors ranging up to 30. It is concluded that a contrast multiplier of 2 applied to the standard function would adequately account for the effect of ocular defocus for 95% of the population.

by A. W. Johnston; B. L. Cole  
University of Melbourne, Victorian College of Optometry, 374 Cardigan St., Carleton, Vic., Australia 3053  
n.d. ; 9p 13refs  
Availability: Corporate author

HS-801 082

### EXPERIMENTAL SAFETY VEHICLE PROGRAM, QUARTERLY PROGRESS REPORT, 4TH QUARTER OCTOBER-DECEMBER 1973

The U.S. Department of Transportation awarded five contracts for Phase I of the Research Safety Vehicle (RSV) Program. The contractors selected were: the Ford Motor Company; Volkswagenwerk AG; Calspan; AMF, Inc.; and Minicars, Inc. The Family Sedan Experimental Safety Vehicle (ESV) Project will be brought to completion upon issuance of the technological summary report in late 1974. Ford will distribute their final report on their ESV program during the first quarter of 1974. Arrangements have been made for the testing of Toyota and Nissan ESV's in the United States (U.S.). Phase II of the Motorcycle Safety Study, consisting of cost and feasibility studies



been initiated. Plans are being made for participation in the International Experimental Safety Motorcycle meeting to be held in Tokyo, Japan, February 5-6, 1974. Plans are continuing for participation in the Fifth International Technical Conference on ESV's, to include RSV's also, to be held in London, England, June 4-8, 1974. A current listing of all the U.S. ESV Program reports is included.

National Hwy. Traffic Safety Administration, Washington, D.C. 20590  
1974; 25p

Availability: Reference copy only

HS-801 219

#### **EXPERIMENTAL SAFETY VEHICLE PROGRAM AND VEHICLE SAFETY RESEARCH, QUARTERLY PROGRESS REPORT, 2ND QUARTER APRIL-JUNE 1974**

Progress in the Experimental Safety Vehicle (ESV) program and vehicle safety research is reported. Selected subjects in subsystems and basic vehicle safety research are included to encourage a more meaningful and complete technical information exchange among the governments of Japan, the United Kingdom, Germany, France, Italy, and Sweden. Testing in the United States of foreign ESV's continues. Each of the five Phase I contractors (AMF, Calspan, Ford, Minicars, and Volkswagen) is continuing to work on the program definition and vehicle characterization task. Test procedures for this phase are mentioned. Evaluation of a family sedan ESV project is nearing completion and the final report is expected in late 1974. The motorcycle safety improvement program has experienced some advancements including a statement of work, and a contract for study of the accident avoidance capabilities of motorcycles. Other progress included: complete full scale testing of a front wheel anti-lock brake system under varied conditions as applied to a heavy-weight motorcycle; application of a front wheel anti-lock brake system to a lightweight motorcycle; a full scale test series and digital computer simulation study of the "Caster Wobble" phenomena; and full scale instrumented tests of a sample of motorcycles and a range of drivers. A unitized school bus development contract is in the process of procurement. Sub-system research is underway in crash energy management (vehicle structures, biomechanical research, and restraint systems) and crash avoidance research. Some changes have been made in the National Highway Traffic Safety Administration organization to streamline the structure and improve effectiveness. Major research contracts of the Office of Vehicle Safety Research for fiscal year 1974 are listed.

National Hwy. Traffic Safety Administration, Office of Vehicle Safety Res., Washington, D.C. 20590  
1974; 22p

Availability: Reference copy only

HS-801 230

#### **EXPERIMENTAL SAFETY VEHICLE PROGRAM. QUARTERLY PROGRESS REPORT, 3RD QUARTER JULY-SEPTEMBER 1972**

Information on experimental safety vehicle (ESV) programs activities, including significant recent developments, planning schedules, progress, and key decisions, is presented. Summary

exchange agreement between the United States and Japan, the United Kingdom, and the Federal Republic of Germany is also included. Background information of the ESV Program in the United States includes an outline of the objectives of the program, and an outline of the domestic program activities. AMF and Fairchild Industries received contracts for prototype ESV's and General Motors Corporation and the Ford Motor Company contracted to develop ESV's for a token sum of one dollar each. AMF and Harley Davidson are working on the development of an Experimental Safety Motorcycle (ESM). The status of each of these contracts is summarized. Technical advancements have been achieved in the following areas: the design of restraint systems and other factors contributing to the crashworthiness of vehicles; improvement of the brake system design; improving the accident avoidance capability of vehicles; system integration and other safety areas; and testing for design inspection accident avoidance, and crash injury reduction.

by National Hwy. Traffic Safety Administration, Washington, D.C. 20590

Rept. No. PR-3; 1972; 24p

Availability: Reference copy only

HS-801 787

#### **EXPLORATORY ANALYSES OF THE FATAL ACCIDENT FILES (FAF). FINAL REPORT**

A study was undertaken to evaluate the general usefulness of the Fatal Accident File (FAF) and to use the data to investigate the following areas of interest: the analysis of differences in fatal accidents between drivers who had and had not had driver education; the identification of classes of drivers who could become target groups for countermeasures that would reduce injury severity by limiting vehicle speeds; and the investigation of fatal accidents involving trucks, particularly for influences of truck size or weight. The principal value of the FAF files is that they contain a unique source of fatal automobile accident data from January, 1973 through June, 1974, a period when quite unusual driving patterns occurred. It was found that this data base can be used to produce national estimates in limited areas. Future FAF based analyses will generally be more effective when very narrow, well-specified areas are to be investigated than for investigations of a more general nature. Finally, analysis of accident patterns must include comparisons between accidents of all degrees of injury severity (not just fatal) and must ultimately involve measures of exposure. Only by normalization or by comparison of fatal accident patterns to those patterns identified by additional accident and exposure information can meaningful measures of relative importance and priority be given to analytical results of fatal accidents.

by W. W. Belew; H. Wuerdemann; W. F. Horton; R. M. Helfand; W. H. Holter; J. W. Overbey  
Mitre Corp., 1820 Dolley Madison Blvd., McLean, Va. 22101  
Contract DOT-HS-357-3-721-IA-MOD-3  
Rept. No. MTR-6997; 1975; 224p 25refs  
Report for Jan-Jun 1975.  
Availability: NTIS

HS-801 823

### ALCOHOL/SAFETY PUBLIC INFORMATION MATERIALS CATALOG. NO. 3

A catalog designed for use by persons developing new public information programs on alcohol and highway safety is presented. Materials produced for previous alcohol/highway safety campaigns along with journal articles and reports describing and evaluating such programs are listed. The procedures for borrowing the materials are described.

by Ann C. Grimm, comp.  
University of Michigan, Public Communication Group, Ann Arbor, Mich. 48105  
Contract NHTSA-6-5071  
Rept. No. UM-HSRI-AL-75-3; 1976; 217p  
Availability: NTIS

HS-801 829

### MOTOR VEHICLE SAFETY DEFECT RECALL CAMPAIGNS REPORTED TO THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION BY DOMESTIC AND FOREIGN VEHICLE MANUFACTURERS, JANUARY 1, 1975 TO DECEMBER 31, 1975

This tabulation of safety defect recall campaigns includes the make and model, model year, description of the defect requiring manufacturer's corrective action, number of vehicles recalled, date of notification, and identification number. Automobiles, trailers, motor homes, boat trailers, trucks, semi-trailers, buses, electric cars, school buses, ambulances, motorcycles, fire engines, mopeds, hubs, tires, brake wheel cylinders, handlebar bolts, trailer swivel jacks, fans, wheels, shock absorbers, brakes, lock and slide on campers are included. The status of domestic and foreign campaigns completed as of December 31, 1975, is also given.

National Hwy. Traffic Safety Administration, Washington, D.C. 20590  
1976; 89p  
Availability: GPO

HS-801 832

### EXPERIMENTAL SAFETY VEHICLE PROGRAM AND VEHICLE SAFETY RESEARCH, PROGRESS REPORT, JULY-DECEMBER 1975

Progress in the Experimental Safety Vehicle (ESV) Program is reported as part of a periodic exchange of information as per agreement with the governments of Japan, the United Kingdom, the Federal Republic of Germany, France, Italy, and Sweden. Research Safety Vehicle (RSV) Phase II development contractors, Calspan and Minicars, are progressing on their design development contracts. Efforts to date have concentrated on analysis and development testing. Reports on the testing of Japanese and Italian ESV's have been distributed, completing the reporting on tests conducted on foreign ESV's. A contract has been awarded to Calspan for testing additional ESV's. The United Kingdom and British Leyland are providing Marina ESV's for testing in the United States. Planning is continuing for the Sixth International Technical Conference on ESV's, which will be held in October, 1976, in Washington, D.C. Research conducted by the Office of Vehicle Safety

Research in selected system and subsystem areas of crash avoidance, structures, restraints, and biomechanics, as well as safety motorcycle research, is reported.

National Hwy. Traffic Safety Administration, Office of Vehicle Safety Res.  
1976?; 25p  
Availability: Reference copy only

HS-801 839

### EXTENSIONS AND REFINEMENTS OF CRASH COMPUTER PROGRAM. PART 3. EVALUATION OF THE ACCURACY OF RECONSTRUCTION TECHNIQUES FOR HIGHWAY ACCIDENTS. FINAL REPORT

An analytical study was performed to develop an obstacle course of well documented, staged collisions representative of frequently occurring accident configurations and to determine the reconstruction accuracies of the automatic iteration version of the Simulation Model of Automobile Collisions (SMAC) and the simplified Calspan Reconstruction of Accident Speeds on the Highway (CRASH) computer programs. It had been initially estimated that 20 staged collisions could be selected for this purpose. Progress toward achievement of the stated objectives was impeded by the fact that most available results from staged collisions were found, on close examination, to be unsuitable for the intended use. For this reason, the usable reconstruction results of the study were limited to only four examples. Even these examples have shortcomings as standard, well defined and representative accidents. Also, further development of the automatic iteration version of the SMAC computer program was found to be necessary to achieve the reported convergent solutions for axial collisions. It is concluded that an urgent need exists for realistic staged collision experiments to permit quantitative determinations of the accuracies of reconstruction techniques. The limited results achieved within the study are considered to be indicative of very attractive levels of attainable accuracies.

by Raymond R. McHenry; Ian S. Jones  
Calspan Corp., 4455 Genesee St., Buffalo, N.Y. 14221  
Contract DOT-HS-5-01124  
Rept. No. ZQ-5708-V-1; 1976; 46p 6refs  
Report for 3 Apr 1975--15 Nov 1975. Pts. 1 and 2 are HS-801 837 and HS-801 838  
Availability: NTIS

HS-801 849

### STANDARDS ENFORCEMENT TEST REPORTS INDEX FOR 1975.

An index to Standards Enforcement Test Reports of the National Highway Traffic Safety Administration (NHTSA) which were released to the public during calendar year 1975 is presented. It is the seventh in a series of such NHTSA indexes. Entries are indexed by manufacturer, model year, model or part number, pass or fail results, Federal Motor Vehicle Safety Standard (FMVSS) number, component or vehicle identification number, laboratory test number, Compliance Investigation Report (CIR) number, fiscal year of test,

Highway Safety (HS) number, brand or seller, and tire size or body style.

Kappa Systems, Inc., 1501 Wilson Blvd., Arlington, Va. 22209  
Contract NHTSA-6-5069  
1976 ; 524p  
Availability: NTIS

HS-801 850

## **BRAKING EFFICIENCY TEST TECHNIQUE. SUMMARY REPORT. FINAL REPORT**

A braking efficiency test technique has been developed which provides a method whereby vehicle stopping performance can be specified, measured, and compared independently of the test surface. The method provides for an independent measure of the prevailing friction potential of the test surface. This measure is used to normalize the measured stopping performance of the test vehicle. The concept presented is tailored toward a safety argument and toward rulemaking as a potential adaptation to braking effectiveness requirements which currently exist. Braking efficiency tests, which were conducted at the Bendix Automotive Development Center to demonstrate the test method, involved measurement of the limit braking performance of both a passenger car and a heavy truck, as well as the extensive application of a mobile tire dynamometer for measurement of surface friction. The mobile device, a major development of this study, is specially configured for measurement of the peak traction capability of a reference tire at varying load and velocity conditions.

by R. D. Erwin; C. B. Winkler  
University Of Michigan, Hwy. Safety Res. Inst., Huron Pkwy. and Baxter Rd., Ann Arbor, Mich. 48105  
Contract DOT-HS-031-3-765  
Rept. No. UM-HSRI-PF-74-13-2 ; 1976 ; 35p  
Report for Jul 1973--Nov 1974.  
Availability: NTIS

HS-801 851

## **BRAKING EFFICIENCY TEST TECHNIQUE. TECHNICAL REPORT. FINAL REPORT**

A braking efficiency test technique has been developed which provides a method by which vehicle stopping performance can be specified, measured, and compared independently of the test surface. The independence quality of the method derives from a technique by which a measure of the prevailing frictional potential of the test surface is used to normalize a vehicle's stopping performance as measured on that surface. This normalized characterization thus quantifies the efficiency with which the vehicle is capable of utilizing the frictional limitations of the test surface to maximize decelerations. A demonstration of the developed methodology was achieved through the conduct of full-scale testing and the accompanying computations of the braking efficiency measure. These tests involved the measurement of the limit braking performance of both a passenger car and a heavy truck, as well as the extensive application of a new mobile tire dynamometer for measurement of surface friction. The mobile device is especially configured for measurement of the peak traction capability of a reference tire at varying load and velocity conditions. The braking efficiency measurements made during demonstration testing showed the method to be quite repeatable on the short term. The concept presented is tailored toward a safety argument

and toward rulemaking as a potential adaptation to braking effectiveness requirements which currently exist.

by R. D. Erwin; C. B. Winkler  
University of Michigan, Hwy. Safety Res. Inst., Huron Pkwy. and Baxter Rd., Ann Arbor, Mich. 48105  
Contract DOT-HS-031-3-765  
Rept. No. UM-HSRI-PF-74-13-1 ; 1976 ; 220p 123refs  
Report for Jul 1973--Nov 1974.  
Availability: NTIS

HS-801 870

## **INJURY RATE AS A FUNCTION OF TRUCK WEIGHTS IN CAR-TRUCK ACCIDENTS. REV. ED.**

It was found that in both 1973 and 1974, the vehicle weight class with the highest accident fatality rate was the largest weight class (that in which the loaded weight of the truck exceeded 75,000 pounds). Two approaches were used, and this was found in both. Models were designed to determine the effect on highway safety of increasing the loaded weight of the truck from 70,000 pounds to 80,000 pounds with mathematical relationships based on existing data. Car-truck accident data considered in the study were divided into 16 classes, corresponding to the loaded weight of the truck. The number of nontruck occupants killed in each weight class were divided by the corresponding number of accidents, and the fatality rates were used to construct models for each year. Each of the models employed, therefore, implied that the fatality rate for nontruck occupants in car-truck accidents increased with the weight of the truck. The principal conclusions reached in the study were: that the death rate for non-truck occupants in car-truck accidents increases with the weight of the truck; that there is no evidence to suggest that this fatality rate would level off at a loaded weight between 70,000-80,000 pounds; and that the fatality rate for non-truck occupants in car-light truck accidents (trucks with a weight less than 20,000 pounds) is less than half that in car-heavy truck accidents.

by Thomas N. Herzog  
National Hwy. Traffic Safety Administration, Office of Statistics and Analysis  
Rept. No. TN-N43-31-7 ; 1976 ; 27p 2refs  
Availability: NHTSA

HS-801 871

## **PERFORMANCE REQUIREMENTS FOR TURN AND HAZARD WARNING SIGNALS. FINAL REPORT**

Turn and hazard warning signals were evaluated to determine appropriate flasher design parameters. Flash rate, duty cycle, start mode, color, and rear lighting system configuration were evaluated objectively in both day and night conditions. A subjective evaluation of flash rate and duty cycle was also conducted. The relationships between flash rate, duty cycle, nominal voltage maximum light output, and light contrast ratio during voltage on and off phases, were explored. Recommendations were made as to areas of turn signal and/or flasher specification that should be included in the Federal Motor Vehicle Safety Standard 108. Recommendations were also made regarding potential changes in parameters included in the current standard. Further research was recommended to evaluate the effectiveness of the school bus "loading" lamps and strobe lamps, the flasher and signal problems caused by ad-

ding campers and trailers to automotive vehicles, and the effectiveness and potential associated with deceleration signals.

by David V. Post  
University of Michigan, Hwy. Safety Res. Inst., Ann Arbor,  
Mich. 48109  
Contract DOT-HS-4-01001  
Rept. No. UM-HSRI-HF-75-5 ; 1976 ; 123p 22refs  
Report for 1 Jul 1974-2 Jun 1975.  
Availability: NTIS

HS-801 872

### **CITY OF TACOMA SELECTIVE TRAFFIC ENFORCEMENT PROGRAM (STEP)**

A program of selective traffic law enforcement in Tacoma, Washington, utilizing certain new and somewhat controversial methods, is described. A goal was developed of improved officer-violator relationship including the use of verbal contacts and a greatly expanded public information effort, designed to raise the public's awareness of potential accident-causing behavior. Tacoma was divided into three areas experiencing similar numbers of accidents annually and containing roughly an equal number of high-accident intersections. Various combinations of experimental/control group assignments were made in these areas. The method of preventive enforcement used involved a combination of stationary observation at assigned high-accident locations and patrol in a general assigned area. All violators observed were contacted, particularly those committing hazardous violations to whom citations were given. The records of contacted drivers were followed for a period of one year to determine the effects on future driving behavior of verbal warnings or citations. It is concluded that: no accident reduction effects attributable to the program were shown; a highly visible mode of operation was preferred by officers involved in the program; no differences were found between citation and verbal warning groups; use of on-street personnel in the public information effort proved to be a positive experience for both the officers and the public; traffic violator attitudes toward officers involved in the program were more favorable than towards other officers; documentation of verbal contacts was considered by officers to be essential; and maintenance of officer morale would appear to require that no more than three hours per day be scheduled and that unscheduled periods of time be provided between scheduled hours.

by R. H. McConnell; N. A. David  
Tacoma Police Dept., County-City Bldg., Tacoma, Wash.  
98402  
Contract DOT-HS-225-2-385  
1976 ; 89p 1ref  
Report for 16 Jun 1972-31 Dec 1975. Prepared in cooperation with Stanford Res. Inst.  
Availability: NTIS

HS-801 873

### **NORTH DAKOTA SELECTIVE TRAFFIC ENFORCEMENT PROGRAM (STEP). PROJECT DIRECTOR'S REPORT. FINAL REPORT**

The views of the Project Director as related to the five experiments of the Selective Traffic Enforcement Program in North

Dakota are presented. Relevant accident and fatality statistics used in the study are tabulated.

by Orlin C. Bensen  
North Dakota Hwy. Patrol, Bismarck, N.D. 58505  
Contract DOT-HS-224-2-384  
1976; 69p  
Report for Jul 1972-Jun 1975. See also HS-801 874.  
Availability: NTIS

HS-801 874

### **NORTH DAKOTA SELECTIVE TRAFFIC ENFORCEMENT PROGRAM (STEP). FINAL EVALUATION. FINAL REPORT**

Five Selective Traffic Enforcement Program (STEP) experiments conducted in two North Dakota counties are evaluated: the overall effectiveness of the STEP program in one county; a speed enforcement campaign, incorporating public information and conspicuous stationary radar, at a specific STEP location in the other county; the overall effectiveness of the STEP program in the second county; the effectiveness of portable pre-arrest breath testers; and a 55 mph speed limit enforcement effort with varying levels of enforcement. It was found that STEP activities of live patrol and conspicuous observation in the first county were associated with significant reductions in accidents and injuries during a time when these parameters were increasing in the rest of the state. In the second county it was found that radar speed enforcement combined with a public information campaign was associated with a dramatic increase in compliance with the speed limit. Most of the change occurred after the public information campaign and before the enforcement. Because of a change to a 55 mph speed limit which occurred shortly after the start of STEP in the second county, before and after comparisons were not used. Instead, monthly accident and injury data were correlated to monthly manpower assignments. It was found that significant inverse correlations existed between manpower and impact parameters. Portable pre-arrest breath testers were given to enforcement officers assigned to experimental groups and their records were compared to officers assigned to control groups. The officers with the device made significantly more arrests with significantly lower blood alcohol concentrations than those without. A special speed enforcement study yielded inconclusive results due to speed recording equipment programs resulting in inadequate data.

by Kenneth D. Hackman, Jr.; Lewis B. Hayes  
North Dakota Hwy. Patrol, Bismarck, N.D. 58505  
Contract DOT-HS-224-2-384  
1976 ; 169p  
Report for Jul 1972-Jun 1975. See also HS-801 873.  
Availability: NTIS

HS-801 875

### **AUTOMOBILE CONSUMER INFORMATION STUDY CRASH TEST PROGRAM. VOL. 1. SUMMARY REPORT. FINAL REPORT**

by Richard W. Carr  
Ultrasystems, Inc., Dynamic Science Div., 1850 West Pinnacle  
Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-4-00909  
Rept. No. 8268-75-190 : 1976 : 25n 6refs

# **AUTOMOBILE CONSUMER INFORMATION STUDY CRASH TEST PROGRAM. VOL. 2. TECHNICAL REPORT. FINAL REPORT**

A vehicle crash test program was conducted to develop test methodology for a series of vehicle rating tests and to produce a data base for use in determining crashworthiness and damage susceptibility ratings for contemporary automobiles. The crash test program, which was divided into two phases, was conducted over a 15 1/2 month period. During the first phase, ten crash tests of two 1973 intermediate-size automobiles, including rigid barrier, moving barrier, and car-to-car impacts, were performed at speeds ranging from 15 to 30 mph. Phase 2 involved 12 crash tests of the comparable 1974 intermediate-size automobiles, including only rigid barrier, frontal impacts, and car-to-car front-to-rear impacts at speeds ranging from 8 to 35 mph. Static and dynamic vehicle component tests were performed on each vehicle used in the second phase testing. An analytical program was also conducted over the same 15.5 month period in an attempt to develop a predictive methodology for a vehicle rating system that would objectively rate automobiles for crashworthiness and damage susceptibility. The primary tools utilized in analyzing each vehicle's crashworthiness and damage susceptibility characteristics were mathematical models of the vehicle and occupant which simulated their dynamic performance in a crash situation. Exercising the models provided predictions for the same parameters that were measured in a vehicle crash test. The results of this predictive approach were compared with the crash data and an evaluation of the predictive methodology was made. Comparisons between the predictive data and the test data indicate that, in general, the vehicle model is a better predictor than the occupant model, although there is room for significant improvement in both areas. The predictive methodology would appear to be more attractive than crash tests from a cost effective aspect. However, it is concluded that the overall correlation between crash test data and the predictive data is not sufficient to warrant the use of analytical models at this time to provide the data for establishing damage susceptibility or crashworthiness ratings, although there was sufficient correlation to indicate that a predictive methodology could be implemented in the future.

by Richard W. Carr  
Ultrasystems, Inc., Dynamic Science Div., 1850 West Pinnacle  
Peak Rd., Phoenix, Ariz. 85027  
Contract DOT-HS-4-00909  
Rept. No. 8268-75-189; 1976; 189p 7refs  
Report for Jun 1974-Dec 1975.  
Availability: NTIS

HS-801 889

## **SAFETY BELT INTERLOCK SYSTEM USAGE SURVEY. MONTHLY PROGRESS REPORT NO. 12, JANUARY 12, 1976**

The twelfth in a series of progress reports for a safety belt interlock system usage survey is presented. A total of 3,002 completed telephone interviews with owner/drivers of 1975 model cars was conducted from a total sample of 15,154 names and addresses supplied by the motor vehicle departments in 19 cities. A total of 1,230 questionnaires have been mailed to both passive and active restraint system owners as part of a follow-up study of Volkswagen Rabbit owners. Tabu-

lation and analysis of observation and interview data have to be carried out.

by Albert Westefeld  
Opinion Res. Corp., North Harrison St., Princeton, N.J. 08540  
Contract DOT-HS-5-01039  
Rept. No. PR-12; 1976; 3p  
Availability: Reference copy only

HS-801 890

## **EFFECTIVENESS OF VARIOUS SAFETY BELT WARNING SYSTEMS. MONTHLY PROGRESS REPORT NO. 7, JANUARY 12, 1976**

A summary of the results of 4,374 observations of safety belt usage, conducted between August 4 and December 12, 1975, with rental cars returned to the Phoenix, Arizona airport, is presented. In each car the safety belt warning systems were working according to certain contract specifications. The reported observations were carried out as part of a larger study of the effectiveness of various safety belt warning systems.

by Albert Westefeld  
Opinion Res. Corp., North Harrison St., Princeton, N.J. 08540  
Contract DOT-HS-5-01154  
Rept. No. PR-7; 1976; 3p  
Availability: Reference copy only

HS-801 891

## **TEST OF VEHICLE SEATING REFERENCE USING THE SAE J826B H-POINT MACHINE. FINAL REPORT**

A testing program was conducted to develop a standardized H-point machine installation procedure which would provide high confidence that the actual H-point in any given vehicle can be located within acceptable and practical tolerances with respect to the Seating Reference Point (SRP) for purposes of driving safety, manufacturing and quality assurance, and government safety compliance testing. Procedures were selected as those showing the least variability of H-point location from repeated installations. Six 1975 sedans were used in testing. Fiducial marks on the cars were all symmetrical about the centerline of the vehicles, therefore they were used as the primary references for alignment. Horizontal and vertical measurements were made for each vehicle, and the variability of vehicle SRP to the H-point was found to be described by a rectangle with limits of two inches horizontally by one inch vertically. Photographs of the test equipment, complete data records, and tabulated test results are included.

American Testing Inst. Div., Science, Engineering and  
Analysis, Inc., P.O. Box 671, Springfield, Va. 22150  
Contract DOT-HS-5-01140  
1976; 95p  
Report for Jan-Dec 1975.  
Availability: NTIS

HS-801 900

## **TRAFFIC SAFETY '74**

National Highway Traffic Safety Administration activities for 1974 are discussed. Activities in the following areas are considered: pedestrian and bicycle safety; alcohol, drugs, and

selective enforcement programs); highway/traffic engineering programs and vehicle inspection programs for safe vehicles and highways; improvement of occupant and pedestrian protection, vehicle structures, safety belt usage, emergency medical services, and knowledge of biomechanics, and the use of military resources in emergency medical services; improvements in vehicle handling, tires and wheels, brakes, controls and displays, and visibility; and special programs involving international cooperation, data acquisition, analysis, and reporting, Research Safety Vehicles, vehicle rating system, bumper standards, and technical training. A list of motor vehicle and highway safety standards which became effective in 1974 and brief discussion of NHTSA's assistance to the consumer and some administrative changes within the NHTSA are included.

National Hwy. Traffic Safety Administration, Washington,  
D.C. 20590  
1975? ; 43p  
Availability: Corporate author

HS-801 901

### **CITIZENS BAND COMMUNICATION MANUAL. HELP IS NEAR. ADDENDUM 2 TO HIGHWAY SAFETY PROGRAM MANUAL. VOL. 2**

A manual is presented which specifies the procedures and defines the criteria for organizing and implementing Citizens Band (CB) radio operations in those communities which have expressed an interest in CB and have determined that its use, on an organized basis, can contribute to highway safety. It is a part of the National Emergency Aid Radio (NEAR) program of the National Highway Traffic Safety Administration (NHTSA) set up to exploit the use of CB as an existing resource for highway safety on an organized basis in order to save lives, lessen the severity of injuries, protect property, restore the movement of traffic, provide information to the motorist relating to personal safety, and enhance citizen participation in highway safety. The specific objectives of the program are listed. Administrative procedures for developing, implementing, and reviewing a NEAR program are outlined in detail. A CB monitor guide is provided which includes descriptions of monitoring procedures, do's and don'ts on the channel, how to elicit information from callers, operating techniques, and how to log and report calls. Also included is a sample from the NEAR monitor log and a listing of CB equipment specifications.

National Hwy. Traffic Safety Administration  
1976 ; 91p  
Advance copy.  
Availability: Corporate author

HS-801 902

### **HOW TO DEAL WITH MOTOR VEHICLE EMERGENCIES**

A booklet designed to describe some of the most common emergency situations and how they can be handled is presented, with accident prevention and the safety of motorists and innocent pedestrians being the prime concern. The first rule of crash avoidance begins with proper maintenance of the automobile including periodic check-ups, and pre-operation check-ups. Emergency stopping on the highway describes

vehicle; loss of power assisted braking and steering; loss of lights; overheated engines; windshield wiper failure; loss of oil pressure; alternator/generator failure; dropped driveshaft; hood pop-up; submersion of the automobile; loss of lug nuts on the wheels; exhaust system failures; flat tires and blowouts; and driving through water or in heavy rain or snow. Mini-emergencies are also covered, including: unruly children; insects in the vehicle; fire in the ashtray; and clothing and upholstery fires. Also included is a list of first aid and emergency supplies for the car to be carried in the glove compartment and trunk.

National Hwy. Traffic Safety Administration, Office of Public  
Affairs and Consumer Services, Washington, D.C. 20590  
1976 ; 22p  
Availability: NHTSA

HS-801 903

### **RSV PHASE 2. BI-MONTHLY PROGRESS REPORT, JANUARY 17, 1976-MARCH 16, 1976**

Progress on the Research Safety Vehicle (RSV) being developed by Minicars, Inc., during the period January 17, 1976 through March 16, 1976, is reported. Progress reports submitted by subcontractors during this period are included. Two low-speed frontal barrier impact tests, two scale model tests with a lowered sill configuration, and a full scale two-car side impact test with one car stationary were conducted during this period. Fabrication of Build Three structures has continued, with five structures in varying stages of completion. The mechanical elements of the VEAC IV two-car test facility have been made operational, with one-car towing tests and cable release mechanism tests complete. Monsanto Research Corporation reports progress on the formulation of polyurethane foams having a large range of compressive strength properties to be used in the RSVs and on the development of bumper impact type foams and body glove skins. The Budd Company has conducted work on the design of RSV body test shells. The Radio Corporation of America reports on the development of electronic subsystems for the RSV. Systems Technology, Inc., has concentrated on the development of and selection of ride/handling subsystem components, including bucks, tires, and suspension systems. The University of Utah reports progress on the development of the service brake and collision mitigation system for the RSV. The collision mitigation system prototype has been completed and preliminary testing of the prototype system has been conducted. Considerable data on the testing of and design of this prototype system is included. Thiokol is continuing work on a crash bag inflator system for the RSV. Extensive data on the preliminary design analysis of the RSV ride/handling subsystem developed by Systems Technology, Inc., are presented.

Minicars, Inc., 35 La Patera Lane, Goleta, Calif., 93017  
Contract DOT-HS-5-01215  
Rept. No. PR-(Jan-Mar)-76 ; 1976 ; 123p  
Availability: Reference copy only

HS-801 904

### **BRAKES. A COMPARISON OF BRAKING PERFORMANCE FOR 1976 PASSENGER CARS AND MOTORCYCLES**

Data on the braking performance for 1976 passenger cars and motorcycles are presented. The data used was provided by the individual motor vehicle manufacturers. The information presented is based on the distance in feet required to bring the vehicle to a full stop from a speed of 60 mph, measured from the point at which the brakes are first applied, with the brake system operating properly. The braking technique does not permit locking of the wheels, since this might result in loss of directional stability. For passenger cars, the brake pedal force may not exceed 150 pounds for any brake application. For motorcycles, the hand brake lever force applied 1.25 inches from the outer end of the lever may not exceed 55 pounds and the foot brake pedal force may not exceed 90 pounds. The most adverse vehicle weight conditions, either light or maximum load, were applied in listing stopping distance capability. The regulations issued by the National Highway Traffic Safety Administration which state the specific conditions on which the information on braking performance is based are included. The law requires that each vehicle described be able to meet or exceed the performance level that its manufacturer sets forth. Data are presented for both domestic and foreign vehicles.

National Hwy. Traffic Safety Administration  
Publ: Consumer Aid Series v6 pt1 (Jan 1976)  
1976 ; 35p  
Availability: GPO, \$0.95, stock no. 050-003-00226-7

HS-801 905

### **TIRES. A COMPARISON OF TIRE RESERVE LOAD FOR 1976 PASSENGER CARS**

The lowest tire reserve loads reported by the following individual auto manufacturers of all tires recommended for installation on their vehicles are presented: Alfa Romeo; American Motors Corporation; Bayerische Motoren Werke; British Leyland Motors; Morris Garage; Checker Motors Corporation; Chrysler Motors Corporation; Daimler-Benz; Fiat Motor Company; Ford Motor Company; General Motors Corporation; General Vehicle; Honda Motor Company; Nissan Motor Company; Peugeot-Renault; Saab-Scania Automotive Group; SS Automobiles Incorporated; Subaru of America; Toyo Kogyo Company; Toyota Motor Company; Volkswagenwerke; and Volvo.

National Hwy. Traffic Safety Administration  
Publ: Consumer Aid Series v6 pt2 (Jan 1976)  
1976 ; 74p  
Availability: GPO, \$1.80, stock no. 050-003-00227-5

HS-801 906

### **ACCELERATION AND PASSING ABILITY. A COMPARISON OF ACCELERATION AND PASSING ABILITY FOR 1976 PASSENGER CARS AND MOTORCYCLES**

Data on the acceleration and passing ability of 1976 passenger cars and motorcycles are presented. The data, provided by the individual motor vehicle manufacturers, presents the time in seconds and the distance in feet required to pass a truck that

is 55 feet long, both in a "low-speed pass" situation at 20 to 35 mph and in a "high-speed pass" situation at 50 to 80 mph. The figures presented for the high-speed pass situation assume that the truck and the passing vehicles, in separate lanes, are initially travelling at 50 mph, with the passing vehicle 100 feet behind the truck. The passing vehicle accelerates to a maximum of 80 mph, and the end of the measurement is the point where the vehicle is 100 feet beyond the truck. The performance figures presented presume that an air conditioner (or heater), headlamps, and windshield wipers are operating. The figures are computed on the basis of a test-track measurement of the vehicle's acceleration. The regulations issued by the National Highway Traffic Safety Administration which state the specific conditions on which the information on acceleration and passing ability is based are included. The law requires that each vehicle described be able to meet or exceed the performance level that its manufacturer sets forth. Data are presented for both domestic and foreign vehicles.

National Hwy. Traffic Safety Administration  
Publ: Consumer Aid Series v6 pt3 (Jan 1976)

Availability: GPO \$1.65, stock no. 050-003-00228-3

HS-801 908

### **MOTORIZED BICYCLE (MOPED). FINDINGS OF A SURVEY**

There is no general agreement as to what type of vehicle should be considered a motorized bicycle. Terms such as "moped," "motor assisted bicycle," and "motorized bicycle" are commonly used throughout the country to denote anything from mini-bikes to small motorcycles, to bicycles with helper motors on them. The Department of Transportation Federal Motor Vehicle Safety Standards program does not specifically define a motorized bicycle. A study was undertaken to survey states and territories to determine how they were controlling the use of motorized bicycles (mopeds) on public highways, through the administration of motor vehicle and traffic laws. Data used in the survey were obtained through the regional offices of the National Highway Traffic Safety Administration. Each state and territory was requested in 1974 to provide certain basic data. Analysis of the 100% response revealed a degree of confusion over the meaning of certain terms. Questions and answers revealed the following suggestions: that motorcycle safety standards should be applied to motorized bicycles; that educational criteria should be developed; that model legislation and inspection criteria should be developed; and that the term "moped" be dropped.

National Hwy. Traffic Safety Administration  
1976 ; 9p  
Availability: Reference copy only

HS-820 247

### **EXPERIMENTAL SAFETY VEHICLE PROGRAM. QUARTERLY PROGRESS REPORT, 4TH QUARTER OCTOBER-DECEMBER 1972**

Progress in the National Highway Traffic Safety Administration's Experimental Safety Vehicle (ESV) Program is reported. The overall program was reevaluated with respect to near-term (ESV) and longer range (RSV) requirements. The compatibility of near-term ESV specifications with rulemaking plans has

following types of accident avoidance tests were conducted using four General Motors prototype ESV's: brake tests; returnability; passing and acceleration; lateral acceleration; steady state and transient yaw; J-turn; vehicle range; and 45 mph pylon maneuver tests. Crash tests were also conducted with these vehicles: 50 mph flat barrier crash; and 60 mph front-to-rear impact tests.

National Hwy. Traffic Safety Administration, Washington,  
D.C. 20590  
Rept. No. PR-4 ; 1973 ; 23p  
Availability: Reference copy only



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NORTH DAKOTA SELECTIVE TRAFFIC ENFORCE-  
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**University of Michigan, Hwy. Safety Res. Inst., Ann  
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**BRAKING EFFICIENCY TEST TECHNIQUE. TECHNI-  
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**University of New Brunswick, Vehicle Collision Res.**

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1974 GMC 1/2 TON PICKUP/RAN OFF ROAD-  
WAY/FIXED OBJECT COLLISION**

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SINGLE VEHICLE/OFF HIGHWAY/STRUCK A ROCK  
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**University of North Carolina, Hwy. Safety Res. Center,  
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**DEVELOPMENT AND EVALUATION OF THE NORTH  
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**University of Saskatchewan, Transportation Centre,  
Saskatoon, Sask., Canada**

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KENWORTH SEMI-TRAILER/OLDSMOBILE CUT-  
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TION/NOVA/LIGHT STANDARD/FIXED OBJECT  
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MULTIDISCIPLINARY ACCIDENT INVESTIGATION.  
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**University of Wisconsin  
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**University OF Michigan, Hwy. Safety Res. Inst., Huron  
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BRAKING EFFICIENCY TEST TECHNIQUE. SUMMA-  
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**Vandervell Products, Ltd., United Kingdom  
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**Vehicle Equipment Safety Commission, Suite 908, 1030  
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MINIMUM REQUIREMENTS FOR THE DESIGN OF A  
VEHICLE IDENTIFICATION NUMBER SYSTEM FOR  
PASSENGER CARS. REGULATION VESC-15, AP-  
PROVED AUGUST 1975**

HS-018 773

MINIMUM REQUIREMENTS FOR THE DESIGN OF A  
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**Wayne State Univ.  
THE DIESEL AS AN ALTERNATIVE AUTOMOBILE  
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HS-018 705



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 University of Illinois, Dept. of Health and Safety Education,  
 Champaign, Ill. 61820; University of Michigan, Hwy. Safety  
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 Hartford, Conn. 06120  
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 Center for the Environment and Man, Inc., 275 Windsor St.,  
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 University of Michigan, Hwy. Safety Res. Inst., Ann Arbor,  
 Mich. 48105  
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 Environmental Protection Agency; Southwest Res. Inst.  
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- EPA-68-01-0472**  
 Southwest Res. Inst.; Environmental Protection Agency  
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- EPA-68-03-0375**  
 Ricardo and Co., Engineers (1927) Ltd., Bridge Works,  
 Shoreham-by-Sea, Sussex, BN4 5FG, England  
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 Environmental Protection Agency; Southwest Res. Inst.  
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Jet Propulsion Lab., 4800 Oak Grove Drive, Pasadena, Calif.  
91103

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University of New Brunswick, Vehicle Collision Res. Team,  
Fredericton, N.B., Canada

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Saskatoon, Sask., Canada

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University of Saskatchewan, Vehicle Accident Study Team,  
Saskatoon, Sask., Canada

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